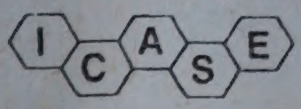
Development of Science and Technology Literacy Materials at the Basic Level

EXEMPLAR MATERIALS

Revised During the Regional Workshop

organized within the framework of
Project 2000+: Scientific and Technological Literacy for All
Philippines: 4-8 November 1997

UNESCO PRINCIPAL REGIONAL OFFICE
FOR ASIA AND THE PACIFIC, Bangkok, Thailand



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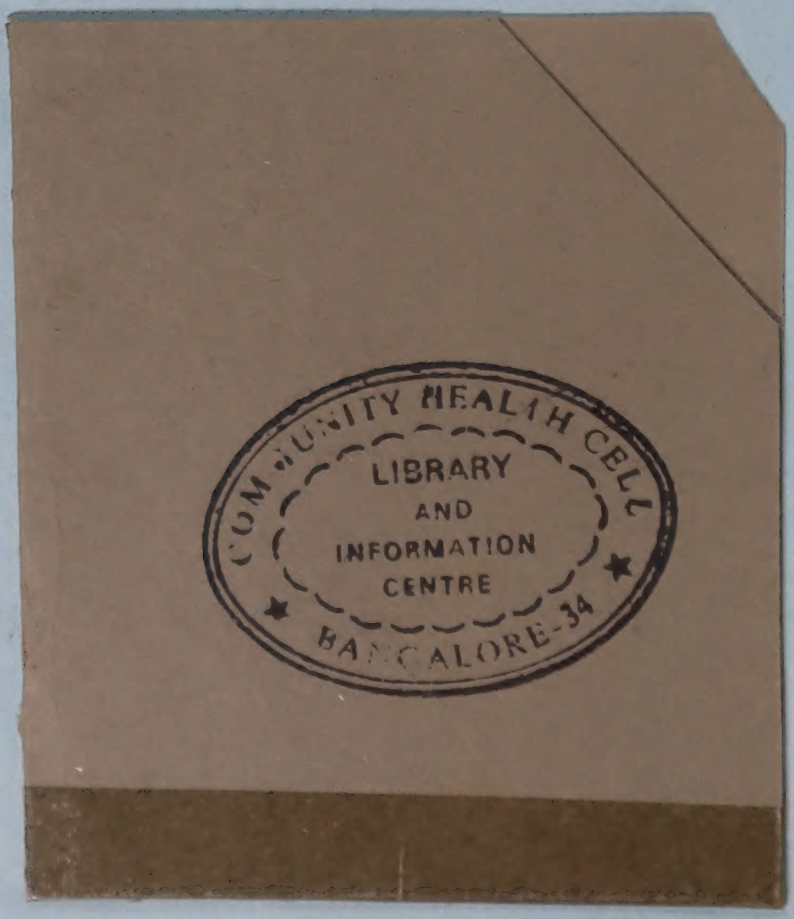
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ASIA-PACIFIC PROGRAMME OF EDUCATION FOR ALL
APPEAL

UNESCO

UNESCO PRINCIPAL REGIONAL OFFICE
FOR ASIA AND THE PACIFIC, Bangkok, Thailand

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INTERNATIONAL COUNCIL OF ASSOCIATIONS FOR SCIENCE EDUCATION

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TABLE OF CONTENTS

	Introduction		iii-vii
	Glossary of terms		viii
	Illustrating the Scientific and Technology Literacy (STL) Philosophy		ix-xi
	The Aims and Rationale of Project 2000+		xii-xiii
U	Unit 1:	Should we construct a waste power plant in our town?	1-12
U	Unit 2:	How to reduce electrical energy consumption	13-23
U/R *	Unit 3:	How safe is our drinking water?	25-36
R	Unit 4:	Selecting a suitable area for rice cultivation	37-47
U *	Unit 5:	The problem of plastics waste – what is the solution?	49-57
R *	Unit 6:	Should we convert farmland into a housing estate?	59-77
R	Unit 7:	Improving the construction of Ubonrat dam	79-90
R/U *	Unit 8:	How to manage household waste	91-100
R	Unit 9:	Using iodized salt to prevent goitre	101-111
U	Unit 10:	Is fluoridation of water useful for preventing tooth decay?	113-120
R/U	Unit 11:	Why is the river dying? Helping living things to survive in a stream	121-139

INTRODUCTION

This material is intended as an additional resource, beyond the textbook, for the teaching of science subjects. The material is very different from the textbook. First and foremost, the material is not simply for reading. Each unit puts forward activities that involve the students. The teacher does not need to talk for long periods of time. Students do not need to read text and try to memorize its content. This material is one attempt at stimulating teacher change, which is of course, no easy task and cannot be achieved overnight. But this material encourages all to get involved in teacher education, to guide science teaching in a new direction and to rethink the purpose of science education in schools for the 21st century.

This Exemplary Material is to help teachers to:

- embrace teaching and learning for Scientific and Technological Literacy (STL)[1];
- increase the effectiveness of teaching by giving specific targets to be achieved;
- increase student interest and thus make science teaching more enjoyable;
- gear science teaching to the attainment of as many of the stipulated general educational goals as possible, and
- if the previous 4 points are achieved, this Material is designed to influence teachers to change their teaching style in other science lessons, and hence further promote STL learning.

The characteristics of the material	* comprises 11 units * within the age range 8-14 * to supplement ordinary teaching The teacher can select one idea and use it where it is felt most appropriate * can be used in more than one science topic. It is left to the teacher to decide on the most appropriate time to use any unit and to time its use such that the students maximize their learning experience * is student participatory * meets educational objectives that go beyond those geared to academic science * is challenging and promotes higher order thinking skills * lends themselves to formative assessment

[1]For an explanation of Scientific and Technological Literacy (STL), see page ix.

Structure of the Units

Each unit can be used by teachers within a teaching sequence of their own choosing. The units are designed to be independent of each other and comprise:

- Introduction
- Students' Guide
- Teacher's Guide

The Introduction

This is intended to give some indication of what the script is about and the educational objectives students are expected to achieve by undertaking the activities provided. The educational objectives are geared to the general goals of education. These goals are specified within a country, as the rationale for attending school. They state what schooling is attempting to achieve. These goals may change for different age levels and may not be explicitly stated in all countries.

The introduction also describes the scientific concepts used, previous knowledge assumed and the learning/teaching materials needed.

Students' Guide

This is the main document to be given to students. A scenario sets the scene for the tasks to be undertaken. The scenario is related to the society and points to an issue or concern on which the script draws. Besides the scenario, a number of individual or group tasks are given which represent the learning activities. These are geared heavily towards co-operative learning, promoting communication skills and either making societal decisions or solving societal problems. As it is important that the whole lesson is under the control of the teacher, the strategy for introducing the students' scripts, the manner in which they are used and the way the lesson is conducted, is for the teacher to determine.

Teacher's Guide

From the teacher's point of view, the guide needs to be considered as the main part of the script. It gives guidance on how to use the script, in the manner intended. It assists the teacher by putting forward a teaching strategy, details how the intended educational objectives are to be achieved and includes any additional handouts for the students that the teacher may wish to give later in the lesson.

The section on 'Achieving the objectives' is very important. It links the student tasks to the objectives. Whether the objectives are actually achieved is determined by carrying out assessment procedures. The section on "Assessment" is divided into the formative assessment part and the summative assessment part. The formative assessment takes place during the teaching process and can be used to guide or inform the students of their progress. The summative assessment takes place after the teaching (in some scripts, summative assessment is not appropriate).

How to Use the Units

The following procedure is suggested:

1. Select a unit that is on a topic of interest.

2. Read through the unit, noting:

   (a) its objectives
   (b) the teaching-learning materials needed

3. If the unit is suitable for the lesson, decide how best to give the scenario and tasks to the students.

   (Photocopying is permitted, but this facility may not be available to the teacher. Often one set of the student's script is needed per student group. However, teachers may feel that each student should have their own copy of the student script,

so that a record can be kept alongside written/ graphical/ tabular reports produced by the student).

4. Plan the lesson (decide whether to follow the teaching strategy suggested, with, or without, modifications. It is stressed that the guidelines are only suggestions and that teachers are free, and even encouraged, to make modifications whenever they feel it appropriate).

5. Ensure students have time to complete the unit.

6. Check that the objectives can be achieved (see - achieving the objectives section).

7. Prepare any formative and summative assessment components you will include within the lesson.

GLOSSARY OF TERMS

ICASE
International Council of Associations for Science Education
A worldwide umbrella body linking national and regional science teacher associations and other bodies involved with science teachers and science teacher educators for the primary and secondary education levels.

STL
Scientific and Technological Literacy (or scientific and technological culture as it may be more aptly translated into other languages).
The knowledge, skills, attitudes and values related to science and technology that are inculcated within school science teaching so as to enable a student to function at a multidimensional level in the society of today and in the future.

UNESCO
United National Education, Science and Cultural Organisation.
A United Nation organisation, with headquarters in Paris, France, supported by member states. It deals directly with the Government within in a country, but forms links with other organisations, including non-Governmental organisations such as ICASE.

Illustrating the Scientific and Technology Literacy (STL) Philosophy

"Teachers teach students, not science"

The need for change is based on the belief that Science Education is called upon to meet new goals, based on the changing needs of the society. With the vast and ever increasing developments in science and technology, this need is great and goes beyond simple changes in content. It encompasses new concerns and issues confronting the society. Science education in fact needs to address a new concept in education - that of Scientific and Technological Literacy for all (STL).

What is STL?

STL is usually taken to mean developing the ability to creatively utilise science knowledge in everyday life to solve problems, make decisions and hence, improve the quality of life. This is based on acquiring educational skills at the intellectual, attitudinal, societal and interdisciplinary levels. If the above represents the target, then STL within formal schooling can be defined as 'that science which is intended within the school curriculum such that science education can maximise its role in aiding students to acquire the goals of general education, as stipulated by society within a country". In other words science is taught in schools, because it is seen as an important part of general education. *The purpose of education is stipulated by the society*. Science taught in schools, therefore, is to enable students to acquire the educational objectives within a science context. It needs to enable students to acquire societal values, personal skills as well an understanding of the scientific method and science knowledge as these relate to the stated goals of education. In addition, because this approach frames science in a societal context, the interaction between science and technology, leading to scientific and technological literacy, is crucial. After all, in the man-made world, it is technology that we see and with which we interact. The science only becomes evident when we need to solve a problem or made a societal decision.

Traits of a person considered scientifically and technologically literate

1. uses concepts of science and of technology, as well as an informed reflection of ethical values, in solving everyday problems and making responsible decisions in everyday life, including work and leisure.
2. engages in responsible personal and civic actions after weighing the possible consequences of alternative options.
3. defends decisions and actions using rational argument based on evidence.
4. engages in science and technology for the excitement and the explanations they provide.
5. displays curiosity about and appreciation of the natural and human-made world.
6. applies scepticism, careful methods, logical reasoning, and creativity in investigating the observable universe.
7. values scientific research and technological problem solving.
8. locates, collects, analyses, and evaluates sources of scientific and technological information and uses these sources in solving problems, making decisions, and taking actions.
9. distinguishes between scientific and technological evidence and personal opinion and between reliable and unreliable information.
10. remains open to new evidence and the tentativeness of scientific/technological knowledge.
11. recognises that science and technology are human endeavours.
12. weighs the benefits and burdens of scientific and technological development.
13. recognises the strengths and limitations of science and technology for advancing human welfare.
14. analyses interactions among science, technology and society.
15. connects science and technology to other human endeavours e.g. history, mathematics, the arts, and the humanities.
16. considers the political, economic, moral and ethical aspects of science and technology as they relate to personal and global issues.
17. offers explanations of natural phenomena which may be tested for their validity.

The Need for Supplementary Teaching Materials

One resource which can guide science education towards greater relevancy for the 21st century is the use of STL supplementary teaching materials. These materials are not extensions of the textbook, but are additional resources for the teacher to call upon as required. As such they are optional materials and can be used as and when the teacher feels it appropriate. If the materials allow students to engage in activities relevant to STL, they enhance the learning situation and hence guide students to achieve the intended educational objectives. This material is developed within this framework.

The Aims and Rationale of Project 2000+

Project 2000+ is an initiative of ICASE and UNESCO that sets out to mobilize worldwide support for action in which governmental and non-governmental bodies collaborate at the country level to achieve a greater level of scientific and technological literacy, perceived necessary for the 21st century. A declaration (UNESCO, 1993) put forward by participants at an international forum highlights the action needed by Governments and other bodies.

The Rationale for Project 2000+

The World Conference on Education for All (1990) declared that "...every person...shall be able to benefit from educational opportunities designed to meet basic learning needs. These needs comprise both essential tools (such as literacy) and the basic learning content (knowledge, skills, values, and attitudes) required by human beings to be able to participate fully to improve the quality of their lives to make informed decisions and to continue learning."

It is clear from the above quotation that today's educational concerns need to be geared to preparing citizens who are empowered to lead productive lives and to enjoy the best possible quality of life. To achieve this, it must be recognized that there is a need to resolve a variety of societal problems which deal with issues such as population, health, nutrition, environment, and sustainable development at local, national and international levels. These societal issues need an increasing degree of scientific and technological literacy on the part of the populace for both understanding and the decision-making involved to stimulate the necessary action. Yet, it would appear that in many countries much basic education in schools includes little that will help students achieve such literacy or feel confident either in applying their knowledge or in dealing with societal issues and the need for a responsibility for action.

Aims of Project 2000+

Project 2000+ recognizes the growing need for a scientifically and technologically literate society and seeks to:

a) identify ways of promoting the development of scientific and technological literacy for all;

b) create educational programmes (both formal and non-formal) in such a way as to empower all to be able to satisfy their basic needs and be productive in an increasingly technological society;

c) encourage the formation of national task forces [involving personnel from Government, Inter-Governmental Organizations (IGOs), and from Non-Governmental Organizations (NGOs) such as Associations for Science Education] to initiate programmes for greater scientific and technological literacy and to identify and support projects promoting aspects of scientific and technological literacy;

d) support the development of a wide range of projects that aim to improve quality of life and productivity in society and that lead to promoting solidarity and cooperation in achieving scientific and technological literacy for all;

e) provide guidelines for the continuous professional development of science and technology educators and leaders;

f) support the evaluation of existing and projected programmes to ensure scientific and technological literacy goals are being met.

UNIT 1: SHOULD WE CONSTRUCT A WASTE POWER PLANT IN OUR TOWN?

(B. REVISED SCRIPTS)

UNIT 1: SHOULD WE CONSTRUCT A WASTE POWER PLANT IN OUR TOWN?

Grade Level: Upper Primary/Lower Secondary (Middle School)

Introduction:

This is an activity to make either an individual or group decision about the value of constructing a waste power plant in a town. The activity is designed to reinforce students' reasoning and their ability to justify action based on societal interest.

The activity is also designed to lead children to overcome the kind of thinking "Not in my backyard (NIMBY)" – i.e. it is all right to cause pollution problems, as long as it is not where it affects me!

Educational Objectives:

This script includes the following learning objectives

1. Identifying and analysing the problems involved in the construction of a waste power plant.
2. Making a group decision on whether to construct a waste power plant
3. Putting forward reasonable justification for the decision made
4. Co-operating as member of a group to arrive at consensus on the issue
5. Communicating orally and in written format to put forward personal views on the problem
6. Detailing energy transfers taking place in relevant instances
7. Explaining the operation of a waste power plant.

Scientific Concepts:

Energy change takes place in burning household waste.
Emissions are given off by the combustion process.
Waste water plants have advantages and disadvantages.

Previous Knowledge Assumed:

Awareness of energy transfer and the ability to state energy transformations in a number of specific instances.

This unit is closely linked with *Unit 5: The Problem of Plastics Waste – What is the Solution?* It is suggested that this unit be followed by Unit 5.

Teaching/Learning Materials Needed:

1. Newspaper reports on advantages and disadvantages of constructing a waste power plant.
2. Newspaper reports on how foreign countries manage their waste power plant.
3. Publications on a waste power plant made by the City Government.

Scenario

The City Government plans to construct a waste power plant in the town. The waste power plant uses, as its fuel, flammable waste garbage, mostly wastepaper, wood, rubber and fabrics, and also the fuel is partly added oil. The waste power plant supplies the town's electrical needs for heating and hot water for people's daily activities.

In some countries like Japan, waste power plants exist near the residential areas. The head of a waste power plant in Japan is quoted as saying the plant can produce electricity as well as hot water for heating houses and other living activities. At the same time, the waste power plant helps reduce both oil consumption and the amount of garbage buried in the ground to less than one tenth.

The City government is not too sure how easy it will be to encourage residents to separate metals and glass from flammable waste. And it is very sure residents will not wish to also separate plastics. But according to environmentalists, the waste power plant will heavily pollute the air, especially in its immediate neighbourhood. This will be especially true with the burning of various types of plastics.

Your Task

1. A pre-activity for younger learners or those who have undertaken work on energy transfer. Collect, list and classify waste materials. Use **small** samples of different waste material and find out by experiment if they burn. (Do this outside in the open, because some waste materials give off harmful gases on burning). Try to compare how much energy is released and how much smoke or bad smell are given off.

2. Obtain information from newspapers and other publications identifying problems and benefits from constructing a waste power plant.

3. Put forward ideas on the operation of a waste power plant in a brainstorming session.

4. List the energy transfers related to the power plant, taking into account each type of waste material that can be used as a source of energy.

5. Discuss, in a group, the advantages and disadvantages of constructing such a plant which run on household waste.

6. Express your opinion and in so doing try to influence the rest of your group to form the same opinion regarding the appropriateness or inappropriateness of constructing a power plant in your town. In the discussion, reflect on what is best for the community as a whole and not simply on a localised view for a group of residents in a particular location.

7. A member of each group presents the group's opinion to the whole class. A whole class position is then determined.

8. Record the decision of the whole class and express its justification in the form of a letter to the City Government.

Teacher's Guide

This activity relates to

a) knowing the energy change that can take place on burning household waste and realising how far this can go to completion and to what extent waste in the form of ash is created;

b) becoming aware of the emissions given off by the combustion process and the effects of a limited air supply;

c) discussing, in groups, the advantages/disadvantages of waste power plants and the presentation of group arguments;

d) reflecting on positive community attitudes and how to combat attitudes signified by NIMBY (it is okay as long as it is good for me and my family).

Teaching Strategy

1. The lesson can begin with an initial brainstorming session on: Why construct a waste power plant in our town? Many ideas should be expressed at this time and the teacher can record these on the blackboard. Once these ideas are exhausted, the teacher needs to guide the class to collect together the ideas so that it can add future sections of the lesson. These will cover (a) energy changes involved in burning rubbish – both partial and complete and (b) the advantages/disadvantages of a waste power plant.

2. The next stage can be to identify what is rubbish and how well it burns.

3. The next part of the lesson is suggested as group work to record as many energy transfers related with the power plant as possible. During this time the teacher goes around the groups, checking the students written records and asking for explanations where anything is not clear. It will not matter that students express obscure energy changes. The point is that this part of the lesson reinforces ideas on energy transfer covered in previous lessons.

4. In groups, students discuss the advantages and disadvantages of constructing a waste power plant in the town and come to a conclusion whether a waste power plant should be built. They can use the energy transfer to guide their decision on the advantages e.g. getting rid of waste, producing heat energy, providing sources of carbon dioxide; and the disadvantages e.g. poisonous fumes, need for ample supply of oxygen, otherwise carbon monoxide is produced, need for fuel such as oil. The important point is that students can come to a decision.

5. Each group presents their decisions and reasoning to the rest of the class. This is followed by the whole class deciding on the appropriate decision to take. All students record this decision and the reasons for it.

6. The above decision was probably influenced by the burning process and disposal of waste, rather than the total social issue e.g. collection/delivery problems, where to put the power plant, pollution control, economics, where to dispose the ash. It also may not reflect the need to view the matter on behalf of all residents and not just a vocal minority. The NIMBY thinking needs to be addressed here. In-groups, students discuss how to overcome thinking like NIMBY. The group then try to present their thinking by constructing a letter, on behalf of the class, to the town council on whether a waste power plant should be built and how the council should take into account complaints that relate to NIMBY thinking by residents.

Achieving the objectives

Objective	This is achieved by
1. Identifying and analysing the problems involved in the construc-tion of a waste power plant.	the initial brainstorming session followed by group discussion.
2. Making a group decision on whether to construct a waste power plant.	students actively participating in the group discussions.
3. Putting forward reasonable justification for the decision made.	students being asked to record their decision (or the decision of the class) and to explain why such a decision was reached in a letter to the City Government.
4. Co-operating as member of a group to arrive at consensus on the issue.	participating in group discussions and reaching decisions within a group and eventually as a whole class.
5. Communicating orally and in written format to put forward personal views on the problem.	students discussing in groups and trying to influence the other to their point of view. The written part is achieved by students developing a letter to the town council on the justification for a decision suggested by the whole class.
6. Detailing energy transfers taking place in relevant instances.	students answering questions posed by the teacher, either orally or given in written format, during the class work.
7. Explaining the operation of a waste power plant.	students participating in group discussion related to energy transfer.

Assessment:

This project can be assessed by formative methods. The tasks that make up this unit are partly based on individual work and the rest on groupwork. Each child should submit a record after the lesson. Objectives 1, 3, 4 and 6 can be assessed from the record sheet.

The sheet can be formed as follows;

Student Record Sheet

"Should we construct a waste power plant in our town?"

Name: _____

1. Where did you get relevant information involved in the construction of a waste power plant?
2. Explain why such decision was reached.
3. Write the degree of your contribution to the group decision.
4. List the possible energy transfer taking place in the waste power plant.
5. Have you changed your original opinion on constructing a waste power plant? Why?

Formative Assessment Strategies

Able to give a Social Values grade (objectives 2 and 3)

A. Repeats the opinions given in newspaper cuttings without giving any individual thought to the issues involved in constructing a waste power plant.

B. Able to isolate the issues and to apply rational thought to making a decision.

C. Able to make a rational decision and to put forward suitable public actions to make the power plant a welcome addition in any neighbourhood.

Able to give a Science Method grade (objective 1)

A. Not really able to identify problems in operating a waste power plant nor put forward suggestions on how these might be overcome.

B. Recognises the combustion problems linked with a waste power plant and can put forward suggestions on how these might be overcome.

C. Able to put forward practicable suggestions to remove problems in operating a waste power plant and suggest how it could operate effectively.

Able to give a Personal Skills grade (objective 4 and 5)

A. Takes little part in the discussions or in putting forward suggestions. Follows the opinion of others.

B. Interested to take part in the discussions and in formulating a letter to the City Government. Able to express opinions that are based on rational thought.

C. Willing to lead the discussion and to guide others towards a decision.

Able to give a Science Concept grade (objectives 6 and 7)

A. Not able to explain the combustion of substances such as oil, wood, paper, plastics, nor the likely products. Does not appreciate the origins of toxic substances.

B. Understands the difference between complete and partial combustion. Recognises the need for a good oxygen supply and a high temperature and how the energy transfer occurs.

C. Understands the energy transfer and steps that can be taken to ensure the exhaust gases are not toxic or contain particulates. Recognises the importance of `scrubbing' gases and the use of an electrostatic precipitator.

UNIT 2: HOW TO REDUCE ELECTRICAL ENERGY CONSUMPTION

Grade Level: Upper Primary/Lower Secondary Level (Middle School)

Introduction:

The increasing cost of electrical energy and the continuous depletion of energy resources mean that it is prudent to conserve energy. This lesson involves students in an activity geared towards identifying measures to reduce electrical energy consumption in the home.

Educational Objectives:

This script includes the following learning objectives:

1. Expressing a value to be placed on minimizing energy consumption.
2. Identifying measures to significantly reduce energy consumption in the home.
3. Cooperating as a member of a group.
4. Communicating orally.
5. Assessing an individual's role and responsibility for energy conservation.
6. Explaining what is meant by electrical consumption.
7. Appreciating that different electrical appliance/gadgets consume varying amounts of energy on computing the cost of electrical energy used in the home.

Scientific Concepts

- Different electrical appliances/gadgets consume varying amounts of energy.

- The total amount of electrical energy used depends on the wattage of the electrical appliance and the amount of time it is used.

Previous Knowledge Assumed:

1. The meaning of the term `watt' or kilowatt' as an electrical unit.
2. Calculating electrical energy consumption and percentages.

Teaching/Learning Materials needed:

1. Calculator (optional)
2. Cartolina
3. Art materials, e.g. poster paint, coloured pens
4. Worksheet 1

Student's Guide

Scenario

Imagine a country in which people are suffering from an acute energy shortage. So as to spread the effects of the deficiency, the electricity supply is cut off to different districts whenever the demand builds up to too great a level. The government calls on the support of the people to conserve energy so that cuts do not have to be made in the electricity supply. Households are requested to reduce significantly their electrical energy consumption, especially at peak demand times.

In almost every household, the following electrical appliances are in use: refrigerator, television, electric fan, flat iron, fluorescent and incandescent lamps, radio, etc. In some cases air conditioners, dryers, washing machines, toasters, electric kettles and electrical pumps are also in use. The electrical appliances consume energy. In this activity, students are asked to identify measures by which household energy consumption may be reduced significantly and to consider effective ways of undertaking significant reductions in energy consumption.

Your Tasks

1. List all the electrical appliances used in your home. Omit any that run solely on batteries. (But don't forget the battery charger!) Specify the number of each item listed. Use worksheet 1. Check this list at home to ensure it is complete.

2. Estimate the amount of time each of them is being used daily, then monthly. (Your estimate can be to the nearest hour).

3. By noting the amount of electricity each appliance uses per hour, calculate the cost of electrical energy consumption of each appliance in one month. (Combine multiple numbers of the same appliance e.g. incandescent lamps).

4. Use pooled information to identify measures/ways by which you can reduce the electrical energy consumption in your home.

5. By applying the measures identified, predict the percentage reduction in the electrical energy consumption for one month. Pay special attention to savings which play a significant role in bringing about the percentage reduction?

6. Compute the amount of money and energy that can be saved by a community of 50 families.

7. Discuss the issue of a person's responsibility to take such measures for the common good and how this can be encouraged.

8. Create a poster that is designed to promote civil responsibility for taking effective measures to reduce energy consumption in each household. (In designing the poster, take special note of these savings which significantly reduce energy consumption).

This activity relates to

(a) an awareness of different electrical appliances used in the home and the energy consumption associated with their use

(b) computing energy consumption in the home and a realisation of which appliances consume most energy, and

(c) how the civic responsibility of people can be awakened to help society overcome the problem.

Teaching Strategy

1. This strategy is based on groupwork and will only be effective if group sizes are small i.e. 3 or 4 students. Each member of the group is asked to list the electrical appliances at home, and the number of each item. If this task is given to students a few days beforehand, they can check their list at home to ensure all appliances are included. (Having a complete list, in itself, is not crucial, but the exercise can make students aware how much the homes of today are dependent on electricity). Each member of the group estimates the amount of time their families use the appliance daily, then monthly. An average can then be taken per group, or each list can be taken separately.

2. Using information shown in Worksheet 1 (wattage of appliance), and the cost per kilowatt hour (kwh), students compute the cost of electrical energy used at home for one month. It is not necessary that the students are familiar with the calculation before this lesson. They can undertake it here for the first time. It should take little teaching time (if any) for students to appreciate the manner in which the calculations are conducted and the repetition of the exercise

will ensure the process is well entrenched. A calculator will ease the numerical multiplication part.

3. Student identify measures by which they can reduce electrical energy consumption in their homes and predict the percentage reduction in the electrical energy consumption in their homes these measures will make. The main point here is that concentrating on minimizing the use of large energy consumers is a very effective way of reducing the percentage of energy consumed.

4. From the prediction, students discuss the issue of a person's responsibility to take measures for the common good so that energy can be saved by each household, the community and the country. It is all very well to identify where energy can be conserved, but it is useless unless the actual reduction takes place. Individuals usually consider the task of others and that they themselves need not worry, because their contribution is too small to be effective. This part of the lesson is thus crucial and looks at how society needs to operate and how citizens can be encouraged to take up their civic responsibility.

5. Students illustrate their views by designing a poster to persuade the public. The posters need to be creative and appeal to a sense of civic responsibility.

Worksheet 1

Data on Electrical Appliances and Corresponding Wattage per kilowatt hour

Name of Appliance/Gadget	*Power Rating/kW*
Electric Fan	0.12 kW
Electric Flat Iron	1.00 kW
Television	0.20 kW
Radio/Tape Recorder	0.20 kW
Fluorescent Lamp	0.010kW
Incandescent Bulb	0.060kW
	0.10 kW
Refrigerator	0.60 kW
Air conditioner	1.00 kW
Electric kettle	1.00 kW
Electric cooker	3.00 kW

Cost of electrical energy = P 2.80/kW hour*
No. of Households in the community = 50
No. of Households in the country = 1,000,000

Item	Number of units per item	Number of hours used daily	Cost energy Daily	Cost energy Monthly
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

* This is approximately US $0.08/kw hour.

Achieving the objectives

Objective	This is achieved by
1. Expressing a value to be placed on minimizing energy consumption	students discussing the importance of minimizing energy consumption, suggesting how to reduce electrical consumption and how this might be publicized to the general public, giving particular attention to develop positive attitudes.
2 Identifying the measures to significantly reduce energy consumption in the home	students undertaking calculations on energy consumption using the information provided and determining the major influences on energy consumption in the home.
2. Cooperating as a member of a group	students participating in the group work.
3. Communicating orally	students actively discussing in groups and jointly working on the calculations.
4. Assessing an individual's role and responsibility for energy conservation	students discussing the issue and then creating a poster for the attention of the public.
5. Explaining what is meant by minimizing electrical energy consumption	students being able to undertake the calculations related to energy reduction when expressed in terms of a rating on an electrical appliance.
6. Appreciating that different electrical appliances consume varying amounts of energy on computing the cost of electrical energy used in the home.	students making lists of electrical appliances in the home, calculating the electricity consumed by them, predicting and then discussing the reduction of electrical consumption.

Assessment:

Formative Assessment Strategies

Able to give a Social Values grade (objectives 1 and 5)

A. Not appreciating that reduction in use of some items can conserve much energy. Cannot appreciate how the general public can be persuaded to reduce electrical consumption.

B. Willing to suggest how individuals can play a role in electrical energy consumption reduction and to appreciate the need to link this to the community good.

C. Able to suggest effective, practical steps to develop a community spirit for the conservation of electrical energy consumption without compromising safety.

Able to give a Science Method grade (objective 2 and 3)

A. Only able to suggest methods to reduce electrical energy consumption by using appliances less, but not able to suggest how this can be achieved effectively.

B. Can suggest methods to reduce energy consumption that are both practical and effective, relying on the need for public education and persuasion.

C. Able to recognize how electrical energy consumption can be reduced appreciably for little change in public behavior by recognizing the methods suggested concentrating on high energy use areas e.g. use of electric cooker, burning of high voltage lights for long periods of time.

Able to give a Personal Skills grade (objectives 3 and 4)

A. Does not play an active part in the discussions nor in putting forward suggestions.

B. Willing to participate in the discussions and in putting forward suggestions. A willing participant in the group in developing a poster.

C. Willing to lead the group discussion and to help others formulate ideas and put them forward. Able to guide the group to make predictions and in developing an effective poster.

Able to give a Science Concept grade (objectives 6 and 7)

A. Does not understand the term 'watt', nor 'kilowatt'. Not able to carry out the calculations effectively.

B. Is able to relate wattage to energy consumption and hence cost. Is able to undertake all calculations.

C. Understands the concept of energy consumption by different appliances and is able to develop a general algorithm that can be used easily to compute costs per 'unit' time.

Summative Assessment Strategies

Able to give a Social Values grade (objective 5)

A. Not able to contribute ideas towards a poster. Contributes little to the construction of the poster.

B. Contributes ideas towards the designing and development of the poster. Plays a full part in its creation.

C. Exhibits creative ideas related to the objectives of the poster and guides others in its development.

Able to give a Science Concept grade (objectives 6 and 7)

A. Not able to undertake calculations in a number of cases.

B. Calculations recorded correctly.

C. Calculations correct and well exhibited based on an algorithm.

UNIT 3: HOW SAFE IS OUR DRINKING WATER?
(B. REVISED SCRIPTS)

Photo courtesy … UNICEF Office, Egypt

UNIT 3: HOW SAFE IS OUR DRINKING WATER?

Grade Level: Upper Primary/Lower Secondary

Introduction:

We can never be sure whether the water that we drink is safe. People depend on the tap or wells for the water which they use for drinking, bathing, and other household needs. Even with bottled water, microorganisms have been found to exist. In many countries bottled water is very expensive.

Drinking unclean water can cause illness. In countries like Pakistan, children are often admitted to hospitals suffering from typhoid, diarrhoea, cholera and other ailments identified with contaminated water supplies.

Some causes of water pollution are bathing, washing, household garbage and harmful microorganisms.

Educational Objectives:

This script includes the following learning objectives:

1. Deciding on the suitability of water for drinking.
2. Detailing procedures for making drinking water safe to drink.
3. Communicating orally.
4. Cooperating as a member of a group.
5. Identifying microorganisms viewed through a microscope.

Scientific Concepts:

- Pathogenic or disease-causing microorganisms are generally present in polluted water bodies.
- Communities have set standards of quality for drinking water.
- Water can be made safe to drink at minimum cost by boiling.

- Water can also be purified by solar distillation and the addition of chemicals.
- Purification methods for water depend on its intended use.

Previous knowledge assumed:

1. Know how to use a microscope.
2. Awareness of methods for removing harmful microorganisms.

This unit is closely linked to *Unit 11: Why is the river dying? Helping living things to survive in a stream.*

Teaching/Learning Materials needed:

1. Two containers for collecting water samples.
2. Spirit lamp.
3. Chart of living organism.
4. Diagrams of microorganisms.
5. Information on expected minimum water standards.
6. Diagram of a solar still.

Scenario

Cleverpupi, a village of 500 inhabitants, is on the banks of a dirty river. It is a poor village and the houses are made of mud with no water supply. All water for washing and other household needs comes from the river. A few weeks ago a number of villagers, especially children, became sick and the regional health worker was called in. Most of the victims suffered from severe dehydration, caused by diarrhoea. A few cases of dysentery were also diagnosed. The village headman decided that some action needed to be taken to improve the water supply. He asked the students in the local school to help.

Your Task

Working in groups of 3 to 4 members, undertake the following experiments:

Undertake the following experiments:

1. Collect samples of drinking water for different locations (sources of water will differ).

2. Place a drop of water taken from the collected drinking water on a microscope slide.

3. Determine whether microorganisms are present by viewing the water drop under the microscope.

4. Draw any microorganisms you see.

5. Compare your illustrations of microorganisms present in water with illustrations of microorganisms commonly present in water.

6. Determine whether the water meets standard requirements.

7. Discuss different ways of making your water safe to drink and how this may be carried out.

8. Devise experiments to show different ways of making water safe for drinking, cooking, washing, etc. In each case indicate the time involved for obtaining safe water.

Teacher's Guide

This activity relates to

a) identifying micro-organisms
b) knowing safety standards and how to make water safe to drink
c) being able to actually make the water safe for use.

Teaching Strategy

1. Students are asked to collect water sample from different sources. To introduce the lesson, a discussion can begin on the possible causes of the illness to the villagers. After the students have identified water as a possible carrier, the teacher can ask students to examine water samples under a microscope and determine whether microorganisms are present in the water.

2. The initial part of the lesson depends on the availability of microscopes. These may need to be borrowed from another school or local industry. The teacher will need to devise ways of allowing the student groups to share the use of the microscope(s). But it is important that the students make the slides for viewing themselves from their own collected water, and not the teacher. The teacher can assist by adjusting the microscope for best viewing and then allowing all groups to see. If much enthusiasm is generated among the students in the use of the microscope, additional viewing time may be needed after the lesson (after school, etc.)

   Without using a microscope, you can get an idea of the purity of water by dabbing a sample on a clean agar jelly plate. The agar plate can be taped to a volunteer's body so that the microorganisms can be incubated by body heat. Learners can then observe the amount of growth stimulated by the sample.

For surface water, the healthy presence of certain larger creatures like fish, frogs, and insects are indirect indicators of the cleanness of the water.

3. The teacher will need illustrations of microorganisms so that students can compare their drawings with those supplied by the teacher and hence, identify the microorganisms. The teacher will also need data on water standards. This will involve chemical tests and insofar as apparatus is possible, students can also conduct these tests on their samples e.g. pH. Students can also boil their sample to dryness to see if any sediments are present.

4. The results of the students investigations will allow students to discuss ways of keeping water safe for drinking. The discussion on making the water safe for drinking is mainly concerned with the removal of microorganisms. Besides boiling, the standard suggestion, but one that needs a source of heat, students can be encouraged to consider solar distillation and the addition of chemicals (sterilizing tabiets). The storage of purified water should be considered carefully also.

5. The students should be encouraged to follow up their discussions and devise practical ways to purify the water with respect to its use for drinking, cooking, washing, etc. Once the plan is approved by the teacher, students should actually carry out their planned investigation. From this, skills involved in scientific method can be taught as well as ending up with practical knowledge useful to the village. The importance of being able to reproduce the experimental results can also be stressed.

6. For example, students can investigate the length of time water should be boiled to kill all microorganisms. The plan could specify that samples of water be boiled for 1 minute, 2 minutes, 5 minutes and 10 minutes. The water from these tests is then checked for the presence of living micro-organisms by viewing through the microscope. The need for

controls would be important e.g. the same original water is used in each sample and the same or similar equipment is used for the experiment.

Achieving the objectives

Objective	This is achieved by
1. Deciding on the suitability of water for drinking.	comparing the results of the experiments with standards set up by the community.
2. Detailing procedures for making drinking water safe to drink.	devising experiments that show different ways of making water safe for drinking.
3. Communicating orally.	discussing within the group.
4. Cooperating as a member of a group.	sharing tasks and reaching consensus on issues within the group.
5. Identifying micro-organisms viewed through a microscope.	undertaking the experimental work and recording the identifications made.

1. Determine whether microorganisms are present in drinking water by viewing water drops under a microscope. Draw any microorganism you may see.

2. Compare your illustration of microorganisms present in water with illustrations of microorganisms commonly present in water.

Assessment:

Formative Assessment Strategies

A. Not able to make a decision on the suitability of the water from the information made available.

B. Able to make a decision on the suitability of the water even though information available may not be sufficiently complete. Able to make reasonable assumptions in arriving at a decision.

C. Able to make a decision on the water supply and to the relative seriousness of any current or future pollution problems. Can suggest how the pollution can be minimized.

Able to give a Science Method grade (objective 2)

A. Not usually able to devise experiments to show how water can be made safe. If able to put forward suggestions such as boiling the water, is not able to suggest the time needed, nor how this can be determined.

B. Able to put forward suggestions for experiments that can make the water safe and be able to specify apparatus, etc. that can be used to carry out the experiments.

C. Able to put forward experiments and the necessary parameters or variables that must be controlled in undertaking the experiments.

Able to give a Personal Skills grade (objectives 3 and 4)

A. Not able to put forward suggestions or communicate in the discussions. Does not participate effectively in the experimental work.

B. Willing to put forward suggestions and cooperate in the discussions in the experimental work.

C. Able to guide the group towards a consensus opinion and in carrying out the experimental work efficiently and effectively.

Able to give a Science Concept grade (objective 5)

A. Not able to relate organisms present in the water with the level of pollution. Does not appreciate the value of the experimental tests.

B. Able to identify organisms present in the water. Able to identify the level of pollution by investigating the organisms present in the water.

C. Able to identify the level of pollution and to explain how the solar still can reduce this. Able to understand the likely causes of the pollution.

Summative Assessment Strategies

Able to give a Science Method grade (objective 2)

A. Experiments not devised nor recorded.

B. Experiments devised to show different ways of making water safe are recorded.

C. Record of the experiments devised to show how water can be made safe exhibit a clear appreciation of the need to control variables.

UNIT 4: SELECTING A SUITABLE AREA FOR RICE CULTIVATION

(B. REVISED SCRIPTS)

Photo courtesy … Mr. Ren Hua

UNIT 4: SELECTING A SUITABLE AREA FOR RICE CULTIVATION

Grade Level: Form 4 or 5 (Year 9 or 10 - Biology Class)

Time : 60-90 Minutes

Introduction:

This exercise involves a study of the suitability of given areas (labelled A, B, C) for rice cultivation. Rice is a staple food for many people around the world, particularly in Asia. Cultivation of rice becomes one of the main agricultural activities in these countries. Currently, some of these countries have to import rice and ensuring economic self-sufficiency is important as it reduces dependency on imported rice.

Educational Objectives:

This script includes the following learning objectives:

1. Deciding on the suitability of an area for rice cultivation
2. Justifying the decision made on the suitability of each area for rice cultivation by considering various factors such as types of soil, environmental concerns and economic consideration
3. Analyzing data in tabular format
4. Comparing the physical properties of the three types of soil
5. Encouraging cooperative learning through groupwork
6. Communicating orally
7. Illustrating scientific knowledge/concepts in relating the properties of soil to plant growth

Scientific Concepts:

- There are various factors affecting rice yield.
- Rice is important to many societies.
- Yield of rice per hectare depends on standard fertilizer usage.

Previous knowledge assumed:

Conditions favoured by rice cultivation

Teaching/Learning Materials needed:

1. Information about rice growing (brochure published by the Department of Agriculture).

2. Textbook on the properties of soil.

Student's Guide

Scenario

The government would like to produce its own rice, since the rice sold in the country is imported from neighbouring countries. As an agricultural officer, you are asked to propose which of three available land areas (labelled A, B, and C) could best be used for rice cultivation based on various considerations, such as suitability of the soil, environmental concerns, economic considerations, etc.

Phcto courtesy ... Mr. Ren Hua

The following information is available to help you make the decision:

	Area A	Area B	Area C
1. Type of Soil	Peat	Clay	Loam
2. Vegetation	Grass and shrubs	Grass and shrubs	Forest
3. Site	Near urban settlement	Rural area	Rural area
2. Location of River	500 metres away	5 kilometres away	3 kilometres away
5. Topography	Lowland and swampy	Slightly hilly	Partly lowland, swampy and partly hilly

Your Task

1. In groups of 3 to 4 members, discuss the following:

   a) the importance of growing rice
   b) physical properties of the three types of soils
   c) conditions necessary for growing rice
   d) use of land areas and its possible impact on people and environment
   e) the cost to be incurred for irrigation of the land.

2. Write down your arguments for or against the suitability of each area.

3. Decide which area your group will choose to be the best possible site for rice cultivation.

4. Present your decision to the rest of the class.

Teacher's Guide

This activity relates to

a) appreciating the importance of rice to many societies
b) comparing properties of the different types of soil
c) making decisions by weighing up various factors

Teaching Strategy

1. The suggestion is that the lesson begins by a class brainstorming session on the importance of growing rice, thus moving students away from canonical knowledge and into considerations of economics, social and environmental factors.

2. The brainstorming session is followed up by groupwork in which students are first asked to consider the suitable conditions for plant/rice growing and then use this knowledge to decide on the suitability of the site. This reinforces earlier work.

3. Once the suitability of each site has been discussed, the students are encouraged to choose one site as the most appropriate and present this choice to the rest of the class.

4. An expert/resource person may be called to give a talk on rice cultivation to give additional information.

5. The students utilize all the information obtained through group discussion and talk given by the expert to write a short report on their decision/conclusion.

Achieving the objectives

Objective	This is achieved by
1. Deciding on the suitability of the area for rice cultivation	group discussion analyzing the tabular data and using the back-ground knowledge reinforced by the brainstorming session.
2. Justifying the decision made on the suitability of each area for rice cultivation	ensuring factors such as inter-ference with the livelihood of other influence on the environment (for example, deforestation) and manpower needs for rice cultivation
3. Analyzing the given tabular data	students making their decision utilizing the data provided in the table. As the components of the data can be considered con-flicting, it is a challenge to the students to analyze the data towards the decision they con-sider most appropriate in terms of economic self-sufficiency.
4. Comparing properties of different types of soils.	students undertaking class discussions
5. Encouraging cooperative learning through groupwork.	students working together in groups and arriving at a consensus common decision through discussion.
6. Communicating orally	taking an active part in the discussion within the groups.
7. Illustrating scientific knowledge/concepts in relating the properties of soils to plant growth.	students participating in group discussion.

Assessment

An assessment of achievement of the objectives of this instructional material can be attained by both formative and summative methods.

Formative Assessment Strategies

Able to give a Social Values grade (objectives 1 and 2)

A. Not able to decide on the suitability of an area for growing rice, or if does so, it is a guess without justification.

B. Able to justify any discussion on the suitability of an area for growing rice.

C. Not only able to justify any decision, but is able to equate this with the social concern of the people and the need for sustainable development for the future.

Able to give a Science Method grade (objectives 3 and 4)

A. Not able to effectively analyse the data given in tabular format and compare the properties of the different types of soil.

B. Able to analyze the tabular data and compare the different types of soil so that decisions can be made on the area best suited to the growing of rice from a scientific point of view.

C. Able to analyze and compare the data so that decisions can be made geared to the economic self sufficiency taking in to account environmental considerations.

Able to give a Personal Skills grade (objectives 5 and 6)

A. Does not participate in the discussions and depends on others to analyze the data.

B. Willing to participate in the discussions and to put forward opinions.

C. Able to lead the discussions and guide others to formulate an opinion bearing in mind the various factors.

Able to give a Science Concept grade (objective 7)

A. Has little understanding of plant growth and the part played in this by the soil.

B. Able to explain the function of the soil in plant growth and the need for different soils for different types of plants. Able to explain soil needs for rice growing.

C. Able to explain soil needs for plant growth and how the soil can be treated to maximize soil conditions for growing plants such as rice.

Summative Assessment Strategies

Able to give a Social Values grade (objectives 1 and 2)

A. Report does not indicate a decision on the suitability of an area for growing rice, or if it does so, it is a guess with justification.

B. Report justifies decisions on the suitability of an area for growing rice.

C. Report not only justifies decisions, but equates this with the social concerns of the people and the need for sustainable development for the future.

Able to give a Science Concepts grade (objective 7)

A. Report not written, or if produced, shows poor understanding of soil formation or the role of soil in growing plants.

B. Report shows an understanding of different types of soil and their advantages and disadvantages.

C. Report shows an understanding of soil and illustrates how soil can be treated to maximize soil conditions for growing plants such as rice.

UNIT 5: THE PROBLEM OF PLASTICS WASTE - WHAT IS THE SOLUTION ?

Grade Level: Upper Primary (Grade 5 or 6)

Introduction:

Modern technology has created the plastics age. Plastics do not easily decay and can thus, be used for a long time. Plastic bags have made human life easier. However, they have also created problems especially to the environment, because many users of plastic bags throw away the used bags in any place. As we have learned, plastic bags are made up of non-decaying substances and they are difficult to get rid of.

Educational Objectives:

This script includes the following learning objectives:

1. Deciding on ways to handle plastics waste.
2. Identifying society's value on responsible action by citizens regarding the discarding of plastics waste.
3. Awareness of the different ways of making and using plastics.
4. Developing students ability for co-operative learning.
5. Developing communication skills by participating in a debate.
6. Understanding the potential and difficulties in recycling plastics.

Scientific Concepts:

- Plastics do not easily decay.
- Plastics have made human life easier.
- There are difficulties in recycling plastics.

Previous knowledge assumed:

This unit is closely linked with *Unit 1: Should we construct a waste power plant in our town?*

Teaching/Learning Material needed:

- Different kinds of plastics
- Poster paper, pentel pen, coloured paper, coloured pens

Students' Guide

Scenario

Plastic bags are very cheap to produce and convenient to use. However, unlike paper bags, they are not biodegradable. This causes problems. For example, when heavy rains come to the village, the water could not flow freely causing the streets to be flooded. The community drainage becomes clogged by plastic bags which people throw away - in canals, by the roadside, in the marketplace etc. Are plastic bags, therefore, such a good idea?

Your task

1. Undertake a group investigation of one of the following topics.
   a. how plastics are formed
   b. the many types of plastics
   c. perceived advantages of plastics bags over paper bags (consider strength, weight, cost, energy needed to produce, use of finite resources)
   d. the recycling potential of plastics - its feasibility.

2. Each group presents its findings for the topic chosen as a display with one member making an oral presentation to the rest of the class.

6. Discuss the problems of using plastics and how these can be overcome.

7. Debate whether plastic bags are good or bad for use in society.

5. Design a poster on using/discarding plastics wisely.

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Teacher's Guide

This activity relates to

a) finding source of information on plastics
b) recognizing the problems caused by plastics once they have served their use
c) developing a social responsibility for the environment

Teaching Strategy

1. Students can begin this topic by undertaking a project to obtain information from secondary sources. In this way the groups cover much of the information gathering part of the curriculum related to plastics and how this affect their lives. Students will need to do this largely outside of the classroom so that they can search through various sources (library, industry, government testing station, etc.)

2. Having obtained suitable information, the students then mount a display of their findings so that their presentation to the rest of the class is visual rather than simply verbal (the display is most probably undertaken as wall charts). Interest is aroused by group presentations to the rest of the class highlighting various aspects of the display.

3. With the background on plastics, students working in groups can then begin to discuss problems relating to the discarding of plastics and reflect on ways to overcome this. They are likely to bring up (a) recycling and (b) responsible attitude on discarding rubbish.

4. Students record the outcomes of their discussions and this is handed to the teacher for marking.

5. The student debate needs to involve 4 students arguing for the motion and 4 students arguing against. The lead student for the motion begins and it is recommended that there is a time limit of 2 minutes per speaker. The rest of the class

make up the judges panel with the teacher as the non-voting chairman. The motion is suggested as 'A charge should be made on plastic bags supplied in shops'.

6. Students consider ways, in their groups, to develop a societal responsibility among the public concerning the discarding of plastics waste. These efforts culminate in a poster, designed by the group, on their attempt to educate the public on their civic responsibility.

A Further Extension

Students implement a project on community participation. A slogan maybe produced such as: "Keep our community clean and neat". The students invite members of their households and other community members to go around to collect not only plastic bags, but any kind of litter. As part of the project students hold a public forum to consider ways of reducing waste and how waste might be recycled.

Achieving the objectives

Objective	This is achieved by
1. Deciding on ways to handle plastics waste.	participating in a debate and designing a poster on the wise disposal of plastics waste
2. Identifying society's value on responsible action by citizens regarding the discarding of plastics waste.	participating in a debate.
3. Awareness of the different ways of making and using plastics.	preparing/interacting with a display and presentation to the whole class.
4. Developing students' ability for cooperative learning.	students working in groups.
5. Developing communication skills.	participating in group discussions and taking part in a debate
6. Understanding the potential and difficulties in recycling plastics.	preparing/interacting with a display and presentation to the whole class.

Assessment:

Formative Assessment Strategies

Able to give a Social Values grade (objectives 1 and 2)

A. Not able to decide on responsible actions with respect to the use of plastics, nor on the value society places on discarding waste responsibly.

B. Able to put forward actions with respect to the disposal of plastics and suggest societal values related to the disposal of waste.

C. Not only able to put forward responsible actions and indicate societal values, but is able to equate this with the social concern of the people and the need for sustainable development for the future.

Able to give a Science Method grade (objectives 3)

A. Not able to develop the project effectively, poor use of information sources.

B. Able to complete the project and obtain suitable information.

C. Able to synthesize date from a number of sources to develop the project and compare data so that points made relate to the local society.

Able to give a Personal Skills grade (objectives 4 and 5)

A. Does not participate in the discussions and performs poorly in putting forward points of view in the debate.

B. Willing to participate in the discussions and to put forward opinions in the debate.

C. Able to lead the discussions and guide others to accept opinions put forward in the debate.

Able to give a Science Concept grade (objectives 6)

A. Has little understanding of plastics and hence, the way they can be used and the types of plastics that can be recycled.

B. Able to explain the meaning of plastics and their importance to modern day society. Able to relate type of plastics to use and show awareness of the difficulties of recycling discarded plastics.

C. Able to explain the formation and choice of different types of plastics and indicate an understanding of the issues involved in trying to recycle plastics.

Summative Assessment Strategies

Able to give a Social Values grade (objectives 1 and 2)

A. Not able to put forward an attitudinal response in the record of the discussions and takes little part in the development of a poster.

B. Able to include attitudes to discarding of waste in the report. Plays a full part in developing a poster that is seen as suitable for educating the public.

C. Shows insight into the attitudinal aspect in tackling problems of discarding of waste. Able to show much creativity in developing a poster that can appeal to the general public.

Able to give a Science Concept grade (objectives 6)

A. Project display poor showing little evidence of understanding of collected data.

B. Able to develop a display of data collected from information sources that shows an understanding of the topic studies.

C. Able to produce a display highlighting concisely the key points related to the topic studies in the project.

UNIT 6: SHOULD WE CONVERT FARMLAND INTO A HOUSING ESTATE?

Grade Level: Upper elementary

Relevant unit in the curriculum where this topic can be integrated : Soil

Introduction:

Land use is a problem in many countries. Put simply, if we convert agricultural lands for housing estate, we will lose space for our crops, thereby reducing food production.

Educational Objectives:

This script includes the following learning objectives:

1. Developing a sense of responsibility for using land appropriately
2. Deciding on whether it is appropriate to use fertile land for a housing estate (houses and streets)
3. Designing and performing investigations that show soil fertility
4. Cooperating as a member of a group
5. Communicating orally and in written format
6. Comparing the composition and characteristics of different soil samples
7. Stating reason why topsoil must be used wisely.

Previous Knowledge Assumed:

1. Plants' direct dependence on fertile soil

2. Animals and people's dependence on fertile soil, through the food chain

Scientific Concepts:

1. Decayed plants and animals make the soil fertile.
2. Fertile soil support plant growth.
3. Soil conservation is using soil wisely or the right way.
4. Soil is a natural resource.
5. Plants (crops) lose space in which to grow when the fertile land is used for houses, roads and other infrastructures.

Teaching/Learning Materials needed:

1. For Activity 1:
   - 2 glasses
   - sample of topsoil (from the garden and farm)
   - hand lens
   - stick
   - spoon

2. For Activity 2, for each group:
   - sandy soil
   - clayey soil
   - garden soil (rich in humus)
   - 3 identical tin cans with perforations on the bottom
   - 3 clear jars (on which the tin cans will rest)

3. For Activity 3, for each group:
   - some topsoil
   - some subsoil
   - 4 day pots
   - some seeds (e.g. rice, mungbean, corn)

Student's Guide

Scenario

The town of Husseini is a prosperous electronics centre. Its population is increasing due to the influx of workers seeking employment. There is an urgent need for more housing and the town is expanding into agricultural land. The cost of living in this town is fairly low since much of the foodstuff is locally grown. This is possible because the soil is very fertile, although there are problems caused by soil erosion in the eastern part of the town. (That area is separated from the other areas by a range of small, but steep hills). Trees have been felled. The hills make it difficult for the town to expand to the east. Not only are they steep but they are forested. A cheaper option is to expand into fertile agricultural land to the north, west and south. As the town expands the amount of land to grow local produce decreases, yet the demand for farm products increases. This is pushing up prices. Building to the east is not only more costly because of the area being hilly, but it would also entail cutting down the trees. A meeting of some town officials and other individuals is held to consider this problem and to decide whether it is appropriate to allow housing to further encroach on agricultural land.

Your Tasks

Work as a group and undertake the following tasks:

1. From knowledge obtained about soil formation, and from related laboratory activities:

   a. Determine whether soils are of different texture.

   b. Show which soil type absorbs more water. Make a suitable display for your results.

   c. On your display suggest what the results of your experiments tell you about soil that is very important for farmers.

2. Farmers believe that topsoil is more fertile than subsoil. Plan an experiment to find out whether the farmer's statement is right or wrong.

3. Discuss within your group what you can infer from pictures 1 and 2.

Figure 1 – A poor soil with very few plants growing.

Figure 2 – Land with several gullies showing the soil is washed away (the gullies were probably made by running

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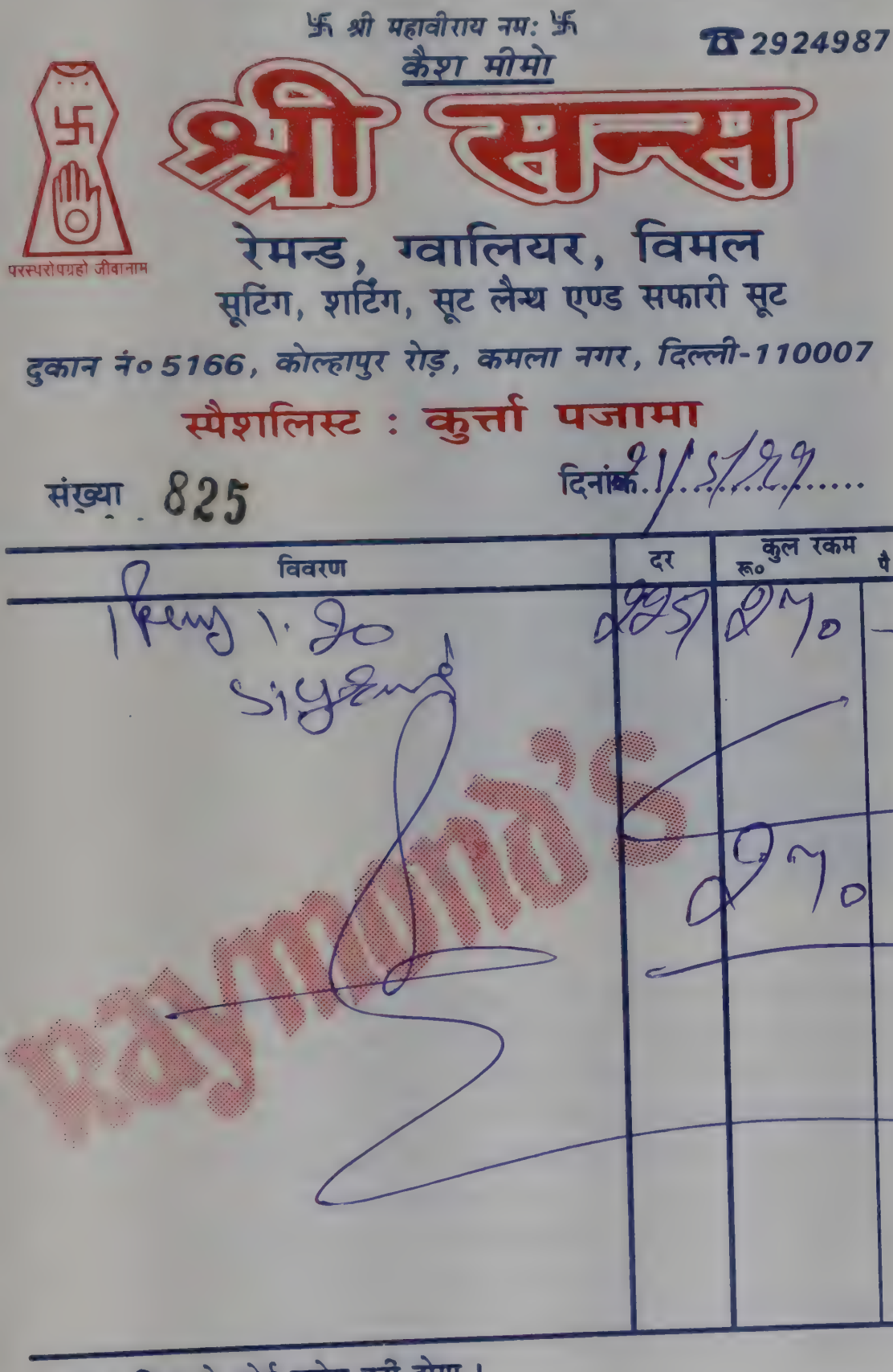

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Teacher's Guide

This activity relates to

a) what is a good soil for growing crops
b) the process of soil formation
c) the issue of constructing housing, other facilities on fertile land.

Teaching Strategy

1. Students can begin by brainstorming the scenario and putting forward suggestions on what can be done. The teacher can then suggest that the students should discuss the issue further.

2. Rather than telling students about good soil, soil formation, and how we must preserve our farmland, student groups undertake a set of activities involving independent library research to obtain information on soil formation.

3. The teacher can ask the students what is meant by fertile soil and soil conservation. If the students have a very good grasp of soil fertility, then the experimental part of the lesson is unnecessary and the teacher can move straight to the discussion of the scenario. Assuming the students' ideas about soil fertility are hazy the teacher guides the students to undertake some fact-finding investigations before attempting the discussion on the scenario. The student groups undertake laboratory activities to enhance process skills e.g. observing, describing, communicating results in tabulated form, designing and carrying out an investigation.

4. For Activity 1, the different groups can be assigned to bring topsoil from their garden or farm. From the result, the pupils are guided to realize that wherever the location, garden soil and farm soil is actually topsoil containing much organic matter.

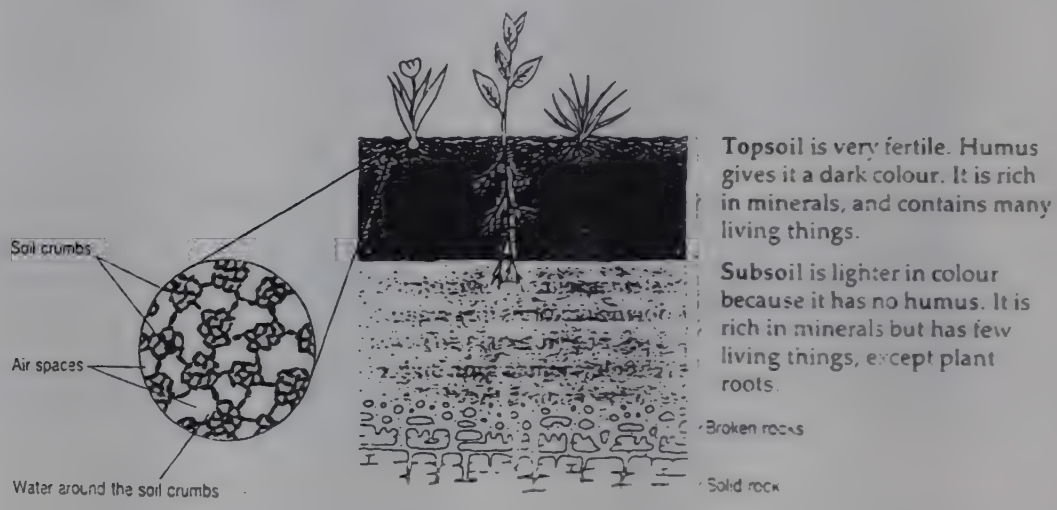
5. The activities should be fun for the students and at the same time a challenge. The students need to think for themselves. The teacher's role is to guide and encourage those who find the challenge formidable and feel like giving up. The teacher in such a circumstance will need to step in and guide the students accordingly without taking away all challenges completely (otherwise we are back to the `telling about situation').

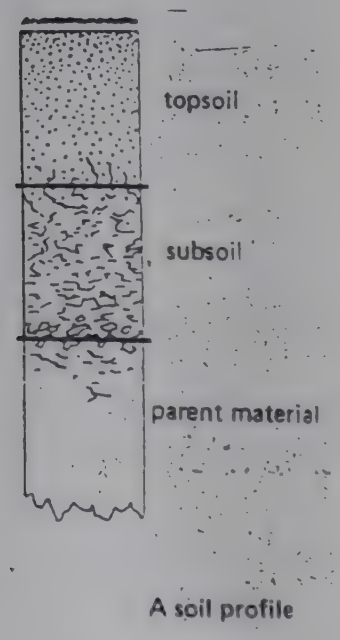
6. Role playing activity. Once students are familiar with soil fertility and soil formation, they are guided to return to the societal discussion on whether to ban construction on fertile agricultural land.

7. Each student in a group plays a role of a person with vested interest in the scenario situation and tries to act as that person would likely perceive the situation.

Student's Hand-Out

Soil is essential for life, since plants obtain nutrients from the soil and animals eat plants. People depend on the soil for growing crops, fruits, vegetables, etc. Water needed by plants is also held by the soil. Soil is formed from the disintegration of the bedrock. It takes a very long time to form one centimetre of soil – maybe about two hundred years.


Soil crumbs
Air spaces
Water around the soil crumbs
Topsoil is very fertile. Humus gives it a dark colour. It is rich in minerals, and contains many living things.
Subsoil is lighter in colour because it has no humus. It is rich in minerals but has few living things, except plant roots.
Broken rocks
Solid rock



A soil profile

Knowing about the importance of soil, and the time it takes for its formation, is it wise to protect our soil, if people and other living things are to survive?

Procedure:

1. Look at the soil. What colour is the soil?

2. Spread out the soil on a white sheet of paper. Observe the soil with a hand lens. Use the stick to run through the soil. What do you find in the soil?

3. Half-fill a glass with water. Pour the soil into the water. Stir the water well. Let it stand for 10 minutes. Observe what happens to the soil. Record your observations.

4. If you see something on the water surface, take it out with a spoon and put it on a piece of paper. What is it that you took out from the water surface?

5. Pour the water into another glass. Take samples of the different layers of soil formed in the glass. Place them on the three sheets of paper separately.

6. Observe carefully the soil you placed on each sheet of paper. Use a hand lens to examine the soil. Record your observations by completing the table below.

Sample record

Table 1. Observations of soil sample

Colour	
Things in the soil	
Layers of soil particles	

Activity 2 ***Which soil type holds more water?***

1. Plan an experiment to:

   a) measure the amount of materials found in the soil.
   b) show which soil type absorbs more water?

2. Record your plan.

3. Carry out your plan after discussing it with your teacher.

4. Record your results in a very visual manner so that they can be compared with the results from other groups.

5. Also present your group's suggestions on the following:

   a. Which factor(s) affect the absorption of water in the soil? (permeability)

   b. Which soil is better for plant growth?

      - the type which lets most water to pass through?
      - the type which lets some water to pass through?
      - the type which lets very little water to pass through?
      - others (explain)

   c. Which plants or animals are abundant in your soil sample?

   d. In which sample of soils do you think a plant will grow better?

Activity 3 Topsoil vs. subsoil

Farmers believe that topsoil is more fertile than the subsoil.

1. Plan an experiment to find out whether the farmer's statement is right or wrong.

2. Record your plan.

3. Carry out your plan after discussing it with your teacher.

Some areas have lost their topsoil. Study pictures 1 and 2. In your groups discuss what the pictures illustrate.

Soil with very few plants growing.

Land with several gullies showing the soil is washed away.

Activity 4 ***Role play***

Because of rapid population growth, in recent years some farming areas inside or near cities have been converted into housing estates, roads, hospitals, schools, recreation centres, etc. Some people believe that building of infrastructures have to take place if development is to continue. Others say, we are destroying the source of man's survival.

Study the problem, - *Should we build houses and roads where the land is fertile?*

To undertake the activity, each group will talk about the problem and propose a solution. You will play the role of the following individuals in the important meeting:

1. Town mayor
2. Councillor
3. Land developer
4. Official from the Department of Environment and Natural Resources (DENR)
5. Farmer

Each member of the group plays a different role. The town mayor acts as the chairman of the group.

Description of the players:

Mayor Lim: You are the highest town official who implements policies, which will be good for the well-being of the city/town.

Councillor: You belong to another party different from that of the mayor. You also want to do what is best for the people. You know that the town will earn from the sale/rental of the houses.

Land developer: You are interested in building houses for people who will be employed in [illegible] more the town will grow and prosper. Of course you will earn a lot of money as well.

DENR Officer: You have made studies of the land in question. You know that the subdivision for housing will mean bringing water, electricity, and need a [illegible] disposal system. The land will be lost [illegible] from other areas.

Farmer: You and many other families depend on the farm for your livi[illegible] If houses are built, you will lose your livelihood.

Achieving the Objectives

Objective	This is achieved by
1. Deciding on whether it is appropriate to use fertile land for the construction of buildings	actively participating in the role play.
2. Devising and performing investigations that show soil permeability and fertility	the students planning and carrying out experiments on permeability and soil fertility.
3. Cooperating as a member of a group	students willing to participate in the experiments, in the group discussions and role play.
4. Communicating orally and in written format	students actively participating in the group discussions and role play, presenting the results of experiments in a visual manner.
5. Comparing the composition of different soil samples	students recording differences between soil samples.
6. Stating reasons why topsoils are usually fertile and give examples of how permeability takes place	completing the appropriate section of the worksheet.

Assessment:

Formative Assessment Strategies

Able to give a Social Values grade (objectives 1 and 2)

A. Not able to make a decision concerning the use of agricultural land but follows the lead of others.

B. Able to make a decision based on rational thought.

C. Incorporates economic, political, social and environmental considerations in making a decision on land use.

Able to give a Science Method grade (objective 3)

A. Not able to suggest a useful experiment to test for topsoil. Carries out experiments given, but does not reach useful conclusions.

B. Able to devise an experiment to test the advantages of topsoil and to reach a conclusion from investigations on whether soils are of a different texture and which soils absorb more water.

C. In describing an experiment, able to control variables and this answer the question of fertility of topsoil from a number of perspectives. Able to carry out experiments and reach conclusions on soil formation.

Able to give a Personal Skills grade (objectives 4 and 5)

A. Not able to play a role in the role-playing exercise and depends on others to formulate opinions.

B. Able to form a display of the experimental results and to play a role assigned in the role-playing exercise. Able to cooperate with others in the group.

C. Able to lead the group in forming a display, guide all to play a role in the role-playing exercise and in stimulating cooperation within the group.

Able to give a Science Concept grade (objectives 6 and 7)

A. Shows little understanding of the composition and characteristics of soils, not on the manner in which topsoil is destroyed.

B. Able to compare the composition and characteristics of different soil samples and to explain the ways in which topsoil can be destroyed.

C. Able to relate physical and chemical properties of soils based on composition and to explain how topsoil can be preserved.

Summative Assessment Strategies

Able to give a Social Values grade (objectives 1and 2)

A. Display weak and does not illustrate the importance of good soil, nor the need to provide land for the growing of crops as well as housing for the additional people coming to the town.

B. Display illustrates an understanding of the experiments undertaken and the importance of soil to farmers. Suggests both land and housing are important and how this can be balanced.

C. Display is creative summarizing the results of the experimental investigations and illustrating the importance of good soil to the prosperity of the country. Tries to justify a balanced need for land and housing.

Able to give a Science Concept grade (objectives 6 and 7)

A. Experimental results show little understanding of the compositions and characteristics of soils, or their importance.

B. Experimental results compare the composition and characteristics of different soil samples. Explanations given of the ways in which topsoil can be destroyed.

C. Experimental results relate physical and chemical properties of soils based on composition. Explanation given on how topsoil can be preserved.

UNIT 7: IMPROVING THE CONSTRUCTION OF UBONRAT DAM

Grade Level: 11 or 12th Grade
Time Required: 100 minutes (2 periods)
Lesson: Environmental Study as an application of Physics

Introduction:

In this exercise, student's consider the problem of modifying the construction of a dam to supply water to the local community. The teaching strategy used is **a role play**, taking into considerations the views of *engineer, environmentalist, farmer, tourist board member and local government official.* A decision will be made on actions to be taken after the different parties have analyzed the local situation.

Educational Objectives:

This script includes the following learning objectives:

1. Making a decision about a daily life situation concerning irrigation needs of farmers
2. Justifying the decision made about the dam
3. Identifying scientific factors involved in modifying a dam
4. Cooperating as a member of a group
5. Communicating through a role play activity
6. Show an understanding of water pressure and how to calculate water pressure changes with depth.

Scientific Concepts:

A dam functions as a water reserve.
A dam could sustain a certain amount of water pressure.

Previous Knowledge Assumed:

The meaning of water pressure and the ability to undertake calculation related to the pressure of water.

Teaching/Learning Materials needed:

1. has to be identified at the Ubonrat Dam area.
2. Video, poster, … etc.

Student's Guide

Scenario

The Ubonrat dam does not keep enough water during the rainy season. As a result, there is insufficient water during the dry months – not only for home use, but for the irrigation of crops. Farming,. the mainstay of the local economy, is being serious undermined by the lack of water. Farmers are putting pressure on the government to modify the dam to allow it to hold more water. But more water behind the dam means more pressure on the dam walls. The dam would need to be strengthened. And more water behind the dam means flooding a greater area. This land is home to a range of flora and fauna. It is a favourite area for tourists who visit during the summer. Should the dam be modified to trap more water, or should no action be taken and the irrigation needs come from another (far more expensive) source?

The original dam

The main purpose of holding water by building a dam is to keep a reserve of water for the nearby community. The Ubonrat Dam was built about 30 years ago when the population in City Ubonrat was around 2,000. Now the population has increased to more than 6,000 and there is an urgent need to look for a larger amount of water supply. However, Ubonrat Dam is of the type _____ which could only hold water up to a maximum capacity of 1,000,000 cubic meters in its present dimension. This means that it could only sustain a maximum pressure of 10,000 Nm^{-2} which is equivalent to a maximum depth of 30 meters water.

Your Tasks

1. Discuss the problem related to Ubonrat dam in groups of 5 students.

2. Taking part in a role playing exercise in which you play the role of one expert to try to make a decision on the Ubonrat dam problem.

   Five groups of personnel are identified for participating in the role playing exercise: Engineers, Environmentalists, Farmers, Local Government officials, Tourist board member – Worksheet 1.

3. Reach a decision within your group and prepare one member of the group to give a short presentation to the rest of the class to try to convince them that your decision is the most appropriate.

4. Participate in a whole class discussion to determine the whole class decision on the issue.

5. Record the class decision made, the arguments in its favour and then suggest how best to proceed to tackle the problem. In making this suggestion be specific as to which personnel should undertake what tasks and in which sequence.

Teacher's Guide

This activity relates to:

a) recognizing the conflicting factors involved in a sustainable development problem
b) trying to make a decision by balancing developmental factors against environmental concerns
c) a familiarization with water pressure.

Teaching Strategy

1. The students are asked to discuss the problem in groups. This is to ensure the students appreciate the problem and realize there is no simple solution.

2. Once the problem is understood, each group engages in a role playing exercise. The five members of the group each take on a different role and try to put forward that point of view during a discussion session. (If a chairman is required, and is the person who starts the discussion and keeps it going, this is the local government official.) Worksheet 1.

3. After all points have been discussed and no new factors are being brought up, the group takes a vote. The local government official from each group then present the decision of their group to the rest of the class.

4. After the presentation, a whole class discussion takes place so that each student can clarify their position as an individual (no longer taking on a role). A class vote is taken as to whether the dam should be modified, a new dam built or no action is taken.

5. Each student is then invited to write a report on the class decision to the local Government, justifying the decision put forward and ensuring details of pressure calculations put forward by the engineer are included.

Student's Handout

The responsibility of the various persons represented in the role playing exercise.

A. The Engineer

The engineer is the expert on dam construction. The engineer is interested in ensuring modifications to the dam are sound and feasible. If not, the engineer will advise on a new dam. Modifications to the dam relate to pressure of water on the sloping wall of the dam and how much this thickness would need to be increased. (It would also relate to how well the added section of the wall can be made to bind with the existing wall, but this aspect is not considered at this time).

B. The Environmentalist

The environmentalist is concerned with the effect of building dams on the environment and to the life of the people in the community. The environmentalist is interested to see there is minimal influence on the flora and fauna and that the aesthetics of the region is not destroyed.

C. Farmers

The farmers are the ones who will directly benefit by changes to the dam. They are interested in a lasting solution to their water problems at a cost that is reasonable. The farmers are pushing strongly for modifications to the dam to be undertaken as soon as possible.

D. Tourist Board Member

The tourist board is interested in attracting visitors to the region and promoting the country. They would be concerned if a modification to the dam would seriously affect the tourist industry in the region.

E. Local Government Official

The local Government is the body that has to make the decision (although this could be overturned later by the national Government). The local government is very aware of the importance of the farmers to the local economy (far greater than the effects of tourism) and that a lack of water is also a concern for the residents in the region. On the other hand, the Government does not want to harm the environment and is looking for a sustainable development solution.

Achieving the Objectives

Objective	This is achieved by
1. Making a decision about a daily life situation concerning irrigation needs of farmers.	participating in the role playing activity.
2. Justifying the decision made concerning irrigation needs of farmers.	recording, in writing, the class decision and including the arguments in favour of this decision.
3. Cooperating as a member of a group.	more than one student cooperating to play a given role.
4. Communicate through a role play activity and in written format.	role playing by students either take part directly or by taking part in the decision to be made following the role playing exercise. The written communication is achieved by all students writing the class decision and putting forward the arguments in its favour.
5. Showing an understanding of pressure and the ability to calculate pressure.	being able to perform the necessary calculations to determine whether changes with depth of water the dam is suitable.

Assessment:

There are 3 main tasks that students are involved in the unit:

1. Identifying problems and issues related to the re-construction of Ubonrat Dam.

2. Communicating ideas as how reconstruction of Ubonrat Dam should be conducted through role-play in class, and

3. Making decision as how reconstruction of Ubonrat Dam should be conducted.

Formative Assessment Strategies

Able to give a Social Values grade (objectives 1 and 2)

A. Not able to put forward a decision on how reconstruction of Ubonrat Dam should be conducted. Able to put forward a decision but without a rationale.

B. Able to put forward a decision on how reconstruction of Ubonrat Dam should be conducted by making use of arguments form one specific role only.

C. Able to put forward a decision on how reconstruction of Ubonrat Dam should be conducted by making use of arguments from more than one role. Able to change one decision already made upon listening to the view of others.

Able to give a Science Method grade (objective 3)

A. Not able to identify problems and issues related to the reconstruction of the Ubonrat Dam.

B. Able to identify major problems and issues related to the reconstruction of the Ubonrat Dam.

C. Identifies major problems and issues related to the reconstruction of the Ubonrat Dam and is able to put these problems and issues into perspective in terms of an order of importance.

Able to give a Personal Skills grade (objectives 4 and 5)

A. Able to present ideas but without a sound rationale.

B. Able to present ideas form one specific perspective with supporting rationale.

C. Able to present ideas from one specific perspective with supporting rationale and modify views after taking other's positions.

Able to give a Science Concept grade (objective 6)

A. Not able to explain water pressure nor calculate changes in water pressure in the dam.

B. Able to undertake all calculations related to pressure changes of water with depth.

C. Able to appreciate the advantages of a sloping dam wall and the impact this has on the pressure differential with depth of water.

Able to give a Social Values grade (objectives 1 and 2)

A. Not able to put forward a decision on how reconstruction of Ubonrat Dam should be conducted. Able to put forward a decision but without a rationale.

B. Able to put forward a decision on how reconstruction of Ubonrat Dam should be conducted by making use of argument form one specific role only.

C. Able to put forward a decision on how reconstruction of Ubonrat Dam should be conducted by making use of argument from more than one role. Able to change one decision already made upon listening to the views of others.

Able to give a Science Concept grade (objective 6)

A. Not able to explain pressure nor calculate changes in pressure in the dam.

B. Able to undertake all calculations related to pressure changes of water with depth.

C. Able to appreciate the advantages of a sloping dam wall and the impact this has on the pressure differential with depth of water.

UNIT 8: HOW TO MANAGE HOUSEHOLD WASTE

Grade Level: Upper Primary Level

Introduction:

Getting rid of household waste is everyone's problem. Everyone throws away used papers, old newspapers, bottles, cans, plastic bags, kitchen wastes, such as fruit and vegetable peelings, residues from fish, meat and rice preparation, and left-over, excess or unfinished food. Given the amount of these household wastes, the problem of waste management thus arises.

Educational Objectives:

This script includes the following learning objectives:

1. Deciding on the course of action to manage household waste.
2. Planning a community project on dealing with household waste.
3. Co-operating with members of a group.
4. Communicating orally and in writing.
5. Identifying household waste as either wet or dry and its interpretation.

Scientific Concepts:

Household wastes, if not disposed properly, can cause diseases.

Household wastes are classified according to its biodegradability or nonbiodegradability; dry or wet.

Household wastes could be reduced, reused, or recycled.

Previous knowledge assumed:

- Classification of materials
- Simple properties of matter

Teaching/Learning Materials needed:

Paper and pencil
Poster papers and coloured pens

Student Guide

Scenario

Imagine that you live in a rural community with 30 households. No regular garbage collection occurs because the local government council cannot afford it. As one moves around the community, it is easy to see flies swarming over food and the smell coming from the garbage piles in front of houses is awful. Dogs, rats, cats and scavengers scatter the garbage - most of which goes into canals and drains. Because of these, unfortunate or rather unhygienic circumstances, people, especially children, get sick. Worst of all, many more children will get sick during the rainy season. Getting rid of household wastes is obviously a problem. What can be done? The local government council decided to ask the local schools to see if they could help.

Your Task

1. In groups and by devising a suitable table,

    a. list garbage (wastes) produced in each household
    b. classify the types of waste, taking into consideration the properties of matters and the "Reduce, Reuse, and Recycle" method of waste disposal and
    c. give the source(s) of each waste produced in the household.

2. Discuss in your group the following:

    a. What are the different ways of disposing household wastes?
    b. The possible reasons as to why the people throw the waste indiscriminately outside their houses, or in any place in the community.
    c. Suggest ways in which such habits of rubbish throwing in b can be changed.

3. Report the results of your group discussion on Question 2 to the class.

4. With the information gleaned from various report presentations, a whole class discussion will ensue before deciding on a class consensus on the issue at hand.

5. Plan a specific community project on "how to get rid of household garbage".

Teacher's Guide

The activity relates to:

a) an awareness of household wastes and how this can be minimized
b) the advantages of returning vegetable and other bio-degradable wastes to the ground
c) developing a sense of civic responsibility.

Teaching Strategy

1. After giving students time to read individually the scenario,

   (i) students list and classify household wastes using an appropriate table; and
   (ii) students brainstorm the ways to dispose of the wastes generated earlier.

2. To better appreciate the problem, students make a record of the waste produced in their household over 1 week. These wastes are classified, their sources identified and presented in any suitable form.

3. Based on the properties of matter and the concept of "Reduce, Reuse, and Recycle", the groups discuss the issue of how to address the waste management problem by suggesting socially acceptable methods of disposal, instead of throwing the wastes indiscriminately. This is an important part of the lesson and the teacher will need to go around the groups ensuring that all students are participating in the discussion and that the discussion is covering the expected dimensions. Where the discussion is too narrow, the teacher will need to interject and help raise suitable questions (not give answers) that stimulate wider and in-depth thought.

4. Each group reports back to the class the results of their discussion. The report should be concise and to the point, stressing the main focus. The teacher may need to guide students in this and also to ensure that the rest of the class pays attention so that the reports can be followed by a class discussion in which a class consensus is reached. This will be needed for the community project which follows wherein the whole class is expected to cooperate together.

5. Students go back to their groups to plan a project for follow-up community action. This will be a whole class activity and once the plans have been developed within the groups and shared with the rest of the class, the class can decide on the course of action to take, and which groups undertake which part. The teacher will need to stress the importance of evidence to support any claim. The teacher will also need to stress the need for visual methods of persuasion e.g. posters. The teacher will also need to emphasize partnerships and thus, guide the students to make use of the mass media and to discuss their plans with the local council.

Follow-up

Students organize community projects involving people-participation. Parents and other members of the community will be involved from the planning to the action phase of the community work, focusing on ways and means in which household wastes could be disposed of.

Expected outcomes (to be suggested by students)

- Collection of household wastes, sorting out into biodegradable and non-biodegradable.
- Able to suggest ways of disposal such as reducing, reusing and recycling, and placing biodegradable wastes in compost pits.

Achieving the objectives

Objective	This is achieved by
1. Deciding how to manage household waste.	brainstorming session and the group discussion.
2. Planning a community project dealing with solving the household waste problem.	taking part in the development and the carrying out of the community project, as a group.
3. Cooperation within a group.	students working together in discussing the problem and in developing a plan for the community project.
4. Communicating orally and in written format.	students discussing in their groups and creating a written plan for solving the waste problem.
5. Identifying household waste as either wet or dry and its interpretation.	completing the table after discussions within the group.

Assessment:

This unit makes judicious use of a student-centred learning approach where students, assigned to groups, brainstorm, list and classify household wastes. The tasks assigned require students to listen and talk, as well as read and write to further develop students' two-way communication skills. This section on assessment aims to check and diagnose the extent to which the learning objectives delineated earlier have been achieved as intended. Besides getting to know students' level of skills and understanding, such feedback is central to the improvement of subsequent conduct of this unit.

Formative/Diagnostic Assessment Strategies:

Move around the groups during students' discussion and observe 2 students, 1 each from the teacher-perceived good and weak student categories. [Note: It is imperative that the teacher should group the students heterogeneously in terms of ability i.e. with 1 high, 2 average and 1 low ability student per group]. Award grade A, B or C based on the following described criteria:

Able to give a Social Values grade (objective 1)

A. Identifies poorly the issue at hand. Gross errors are made in identifying and differentiating various types of wastes. Poor presentation of waste disposal suggestions and unable to justify the course of action taken.

B. Identifies the issue and formulates the problem statement, with minimum help from teacher. A wide differing wastes could be generated and classified accordingly to whether or not they are biodegradable. Presents the suggestions on waste disposal at ease, drawing from the discussion made.

C. Identifies clearly the problems and issues. Formulates the pertinent problem statement. Differentiates between relevant and irrelevant data/information in a logical fashion with regard to biodegradable and non-biodegradable wastes.

Present suggestions as to how household wastes could be disposed of in an organized, effective, convincing and practical manner.

Able to give a Science Method grade (objective 2)

A. Not able to put forward positive contribution towards a community action plan

B. Able to develop a community action plan.

C. Able to guide others to develop a community plan and to ensure that actions suggested are justifiable.

Able to give a Personal Skills grade (objective 3 and 4)

A. Too shy to speak or hardly gives any responses during the brainstorming/discussion. Accepts the group's suggestions/views without any indication to seek further clarifications.
Too out spoken, monopolizing the conversation/discussion without adding meaning nor giving opportunity for teammates to voice their opinions.

B. Able to put forward one's own ideas confidently, justifying when need arises. Asks for clarification from teammates occasionally.

C. Able to put forward one's own ideas confidently, intelligibly and convincingly. Listens actively while others talk, seeking clarifications when ideas are vague to him or acknowledging/augmenting/capitalizing on pertinent ideas of others.

Able to give a Science Concepts grade (objective 5)

A. Shows sign of confusion or not being able to define what household wastes are. Makes more than three mistakes while categorizing the group-generated list of household wastes into the domains of biodegradable and non-biodegradable. Not being able to conceptualize the implications of indiscriminate waste disposal on human health and well-being.

B. Defines household wastes without elaborating and giving examples. Categorizes wastes into biodegradable and non-biodegradable from the lists generated and made not more than two mistakes.

C. Defines household wastes in own words, elaborating by giving examples. Expresses accurately the meanings of biodegradable and non-biodegradable from the group-generated list. Exhibits an understanding of the implications of unhygienic waste disposal on human health and well-being by verbalizing the many diseases that could inflict children.

UNIT 9: USING IODIZED SALT TO PREVENT GOITRE

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UNIT 9: USING IODIZED SALT TO PREVENT GOITRE

Grade Level: Grade 5 or 6

Introduction:

Goitre is a disease physically shown by the enlargement of the neck of humans. It maybe due to a total or partial enlargement of the thyroid gland. One of its causes is hormonal dysfunction. Endemic or simple goitre is a result of prolonged iodine deficiency. This kind of goitre is quite common, especially among poor people.

Educational Objectives:

This script includes the following learning objectives:

1. Deciding how a community can eliminate goitre.
2. Involving the learners in transmitting messages of the consequences of iodine deficiency.
3. Cooperate as a member of a group.
4. Communicating orally.
5. Awareness of the consequences of iodine deficiency in human beings,
6. Understanding the role of iodine in the prevention of goitre.

Scientific Concepts:

- Goitre is physically manifested by enlargement of the neck in humans.
- Enlargement of neck maybe due to enlargement of thyroid gland.
- Endemic or simple goitre is a result of iodine deficiency.
- Adding iodized salt to food could prevent goitre.

Previous knowledge assumed:

Parts of the body, functions of glands and hormones

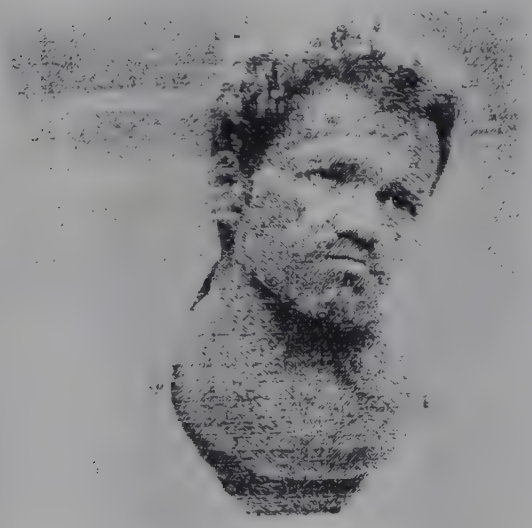
Teaching-Learning Materials needed:

Pictures of people with goitre
Iodized salt
Community data on people with goitre problems
Poster paper, coloured pen

Student's Guide

Scenario

A person with goitre



The picture shows a person with goitre. Such endemic goitre is peculiar to some pockets of population in Bangladesh. In one district, Jamalpur, there is a high report of goitre among the people. What causes this problem and is there anything students can do to alleviate the problem ?

Your Task

The activities are summarized as follows:

1. In small groups, brainstorm ideas about goitre, the consequences of iodine deficiency and whether this is a problem in the community.

2. Report the results of the brainstorming to the class and follow by class discussion.

3. Make a survey of the number of goitre patients in the community - or obtain the data available from the health centre. The available data is analyzed, followed by finding out about the dietary habits of the members of the family.

4. Call a resource person to discuss about the possible causes of goitre.

5. Find out about the properties of iodized salt as compared to non-iodized salt. Discuss whether this is a good idea for combating goitre.

6. Recommend to family members the use of iodized salt to prevent goitre by designing a suitable poster.

Teacher's Guide

This activity relates to:

a) an awareness of the causes of goitre and how this can be prevented
b) understanding the use of iodized salt
c) the need for public awareness that goitre can be prevented.

Teaching Strategy

1. The teacher can begin the lesson by a brainstorming session in which the students put forward their ideas on the problem of enlarged thyroid glands and whether this is a problem in their community through a brainstorming session. In this session, students put forward any idea they have and the teacher records these on the blackboard. All ideas are written down.

2. Following the brainstorming session, students discuss, in small groups, whether action is needed in their community to counteract the problem of enlarged thyroid glands. Where action is required, students put forward suggestions of how this can be undertaken.

3. In their small groups, students develop questions about the problem which they can pose to a visiting health worker to find out more about the disease and how it can be prevented.

4. Teacher invites a health professional to discuss with students about goitre. Each group is permitted to ask a question in turn. The teacher writes this question on the blackboard so that other groups do not ask the same question again. When all questions have been asked, the teacher and the health worker reinforce the answers given by the health worker by asking each student to take part in a quiz. In the quiz, students record answers to questions posed

verbally. At the end of the quiz, students swap papers and mark the paper given.

5. The teacher brings samples of iodized and non-iodized salt to the class. The student groups inspect these and discuss properties of the two samples. The students also discuss whether this is a good way of administering iodine to the community and if so, why it would be effective.

6. Students create posters to explain how the community can prevent goitre, the advantages of iodized salt and how community members can know that the salt is the iodized version.

Achieving the Objectives

Objective	This is achieved by
1. Deciding how a community can eliminate goitre.	discussing in a group and then designing a poster on the use of iodized salt.
2. Involving the learners in transmitting messages of the consequences of iodine deficiency.	designing a poster to publicize the problem of iodine deficiency.
3. Cooperate as a member of a group.	working with the group and arriving at common suggestions for action.
4. Communicating orally.	taking an active part in discussions within the group.
5. Awareness of the consequences of iodine deficiency in human beings.	Interacting with a visitor to explain problems of iodine deficiency
6. Understanding the role of iodine in the prevention of goitre.	creating a poster to explain actions needed by the community to prevent goitre

Assessment:

Able to give a Social Values grade (objective 1)

A. Not able to suggest ways in which a society can eliminate goitre.

B. Able to put forward ways of eliminating goitre and the manner in which this should be tackled.

C. Able to appreciate the importance of eliminating goitre as well as indicating ways of doing this.

Able to give a Science Method grade (objective 2)

A. Not able to develop a questionnaire. Relies on the work of others.

B. Able to make a positive contribution to the development of a questionnaire on goitre.

C. Able to guide others to create a questionnaire that show insight into the causes of goitre and the manner in which it can be eliminated.

Able to give a Personal Skills grade (objective 3 and 4)

A. Not able to work with others to resolve and communicate ideas.

B. Able to work with others to make a common decision.

C. Able to actively participate and convince others to support the idea put forward in the discussion.

Able to give a Science Concept grade (objective 5 and 6)

A. Not able to explain goitre, nor suggest how this can be prevented.
B. Able to explain the causes of goitre and put forwards ways in which this can be prevented.

C. Aware of the causes of goitre and how elimination is possible. Understands the make up and function of the thyroid gland.

Summative Assessment Strategies

Able to give a Personal Skills grade (objective 3 and 4)

A. Not able to design a poster to educate the generate public.

B. Able to design and create a poster that informs the public about goitre and its prevention

C. Able to create an appealing poster that gives a positive image to the general public concerning the need to take preventive action against goitre.

UNIT 10: IS FLUORIDATION OF WATER USEFUL FOR PREVENTING TOOTH DECAY?

Grade Level: Primary 4 **Age:** 10-11
Time Required: 2 periods (80 minutes)

Introduction:

The object of this unit is to decide whether the government has the right to take away free choice. In this case, the unit considers the incorporation of fluoride in the water supply, rather than simply including it in toothpaste. It is used as a method for preventing tooth decay. Students are asked to gather information about tooth decay from a dental clinic. The dentist will be able to show the effects of various substances eaten by children and the action of fluoride in preventing tooth decay.

But is fluoridation always good? Students are given the possibility to explore this channel and determine whether it can also have a detrimental effect. With this in mind, students debate whether free choice is needed and whether the better policy is to educate the public to exercise their choice wisely.

Educational Objectives:

This script includes the following learning objectives:

1. Investigating whether fluoridation of water is an acceptable approach to the avoidance and prevention of tooth decay
2. Justifying any position with respect to a person's freedom on the right to choose
3. Design a questionnaire for gathering information on fluoridation from a secondary source
4. Cooperate as a member of a group

5. Communicating through participation in group work and the preparation of resolution which could reflect the result of the activity

6. Explaining the causes of tooth decay and its prevention.

Scientific Concepts:

Fluoridation of water and toothpaste has been accepted way of preventing tooth decay.
Fluoridation has side effects.
Healthy teeth contribute to a person's well-being.

Previous Knowledge Assumed:

1. Dental Structure
2. Effect of fluoride on the dentine

Teaching/Learning Materials needed:

Student's Guide

Scenario

Children are usually reminded to brush their teeth before going to bed. Brushing means cleaning the teeth with a toothbrush and using certain brands of toothpaste. There are toothpaste which are fluoridated, and there are those brands which do not contain fluorine compounds. In this way, children have a choice. But in some countries, it has been decided to fluoridate the water supply. Now there is no choice. But does this matter, if fluoridation prevents tooth decay?

Your Tasks

1. Brainstorm possible causes of tooth decay.

2. As group work, develop a questionnaire/set of questions for interview. This will help you obtain answers from qualified dental practitioner on the use of fluoridation to prevent tooth decay. Some points to include in the questionnaire might be whether:

   a) fluoridation helps to prevent tooth decay
   a) there are side effects when fluoridation is used
   b) it is possible to use too much fluoride on the teeth
   c) adding fluoride to the water supply would be a better method to prevent tooth decay.

3. Visit the health centre and interview dental practitioner using the prepared questions.

4. Participate in a debate on whether it is a good Government policy to fluoridate the water supply to each household.

5. As a groupwork, prepare a resolution regarding your stand on the issue of fluoridation.

Teacher's Guide

This activity relates to:

a) the causes and prevention of tooth decay;
b) the use of fluoridation;
c) whether individuals should be given a choice on health matters.

Teaching Strategy

1. The lesson can begin with a *brainstorming* session on causes and prevention of tooth decay. The students put forward their ideas and these are recorded on the blackboard.

2. It is expected that fluoridation of tooth paste will be one point brought up in the brainstorming session. If it is not, the teacher will need to raise this point at the end of the brainstorming session. The teacher can also pose the question as to whether the water supply is fluoridated. From the ensuing class discussion, the teacher should not try to answer the questions but guide the students to realise that they have many questions and there is a need to obtain answers. The teacher suggests a visit to the health centre and that visit should be arranged.

3. To prepare the students for asking questions at the health centre and to make sure they have a written record afterwards, the students, in groups, *prepare a questionnaire about the causes and ways of preventing of tooth decay.*

4. The teacher needs to check the questionnaires, both to be aware of student interests and also to ensure that important questions e.g. possible problems with fluoridation, are not overlooked. To avoid overlap, of questions to be asked the teacher will need to decide which group will ask a particular question at the health centre.

5. At the health centre, the *students ask their questions* and complete their questionnaires.

Students are asked to prepare an individual written reports, based on the debate, on the topic "Should fluoridation of water be mandatory?" This is handed to the teacher for marking.

6. Having obtained the necessary background information from the health centre, the students are now ready to tackle the issue of fluoridation and whether it is sufficiently important that it should be put in the water supply. The counter argument is that by putting fluoride in the water supply, an individual's right to choose is taken away. Thus a *debate can be set up on this issue and the students be made aware of the rights of the individual.*

Teacher discusses written reports and indicates the point to be highlighted in preparation for the writing of the class resolution on the issue.

7. The students prepare to take part in a debate on whether the Government has the right to take away free choice – fluoridation of water supply. Four speakers are chosen for the motion and another four speakers against the motion. The rest of the class act as the judging panel and the teacher is the non-voting chairman. The leading speaker for the motion begins the debate and is given 2 minutes to address the judging panel. The first speaker opposing the motion then speak trying to repudiate the points made by the speaker for the motion and then adding additional points. This is repeated by the other speakers in turn. At the end, the judging panel is allowed to ask any questions to seek clarity before the main speaker for the motion is allowed 1 minute to sum up and then a further 1 minute is given to the leader of the opposing team. The judging panel then vote to decide whether the motion is carried or not.

Achieving the Objectives

Objective	This is achieved by
1. Investigating whether fluoridation of water is an acceptable approach to the avoiance and prevention tooth decay	seeking answers to questions when visiting the dental office.
2. Justifying any position with respect to a person's freedom on the right to choose	writing a report following the debate.
3. Designing a form gathering information about fluoridation.	creating a question and use it to obtain information from a secondary source.
4. Co-operate as a member of a group	taking part in joint investigations, developing the questionnaire and in ensuring that suitable answers are obtained at the dental office so that the group can follow their investigations when they return to school.
5. Communicating through participation in group work and debate	taking an active part in the group discussion and putting forward points during the debate.
6. Explaining the causes of tooth decay and its prevention.	discussions following the brainstorming session and completion of questionnaire.

Assessment:

Formative Assessment Strategies

A. Not able to suggest whether fluoridation of the water supply is a good or bad idea.

B. Able to recognize the advantages of fluoridation of the water supply, but also its limitations. Able to decide fluoridation of toothpaste was a more a suitable approach to combating teeth decay.

C. Able to appreciate whether the fluoridation of the water supply was an infringement of peoples rights and whether more emphasis should be placed on the publicizing of fluoride toothpaste.

Able to give a Science Method grade (objective 3)

A. Not able to develop a questionnaire. Relies on the work of others.

B. Able to make a positive contribution to the development of a questionnaire on the causes of tooth decay and the effects of fluoridation.

C. Able to guide others to create a questionnaire that show insight into the causes of tooth decay and the positive and negative aspects of fluoridation.

Able to give a Personal Skills grade (objective 4 and 5)

A. Not able to work with others to resolve and communicate ideas.

B. Able to work with others to make a decision and communicate concentrate ideas during a debate.

C. Able to actively participate and convince others to support the idea put forward in a debate.

Able to give a Science Concept grade (objective 6)

A. Not able to explain tooth decay, nor suggest how this can be prevented.

B. Able to explain the causes of tooth decay and put forwards ways in which this can be prevented.

C. Aware of the causes of tooth decay and why fluoridation is effective in preventing this. Understands the make up and function of different types of teeth.

Summative Assessment Strategies

Able to give a Science Method grade (objective 3)

A. Not able to develop a questionnaire. Relies on the work of others.

B. Able to develop a questionnaire that weeks information on the causes of tooth decay and of fluoridation.

C. Questionnaire developed seeks information on the causes of tooth decay and the positive and negative aspects of fluoridation both for tooth paste and especially with respect to its addition to the water supply.

UNIT 11: WHY IS THE RIVER DYING? HELPING LIVING THINGS TO SURVIVE IN A STREAM

Grade Level: Middle School

Introduction:

The script involves the study of why living things could not survive in a particular stream. The people living near the stream throw away their household waste, wash their clothes, take a bath, etc. The water in the stream has become polluted. The government is anxious to keep the stream alive - safety measures are, therefore, proposed.

Educational Objectives:

This script includes the following learning objectives:

1. Having a positive attitude towards, and a sense of responsibility for, living things.
2. Encourage fellow students to develop respect, awareness and concern for their local environment.
3. Identify ways of keeping the stream alive.
4. Co-operating as a member of a group.
5. Communicating orally.
6. Testing the presence of oxygen in water and hence, determining the causes of oxygen reduction in the stream;

Scientific Concepts:

- Throwing waste in a stream pollutes the water.
- Polluted water contains low oxygen.
- Living organisms do not survive in places where oxygen is not sufficient.
- There are ways of preventing the dying of a stream.

Previous knowledge assumed:

This unit is closely linked with *Unit 3: How safe is our drinking water?*

Teaching-Learning Materials needed:

- pictures of how people use the stream
- poster paper and coloured pens
- water sample
- magnifying lens/microscope
- pH indicator

Student's Guide

Scenario

A stream is passing through a village. The stream is used for washing, bathing, and for other household needs by the local people. This has taken place for hundreds of years. But now dead fishes are appearing in the stream and the number of living organisms is noticeably disappearing. There is a sudden dramatic change in the life of the river. You are brought in as an investigator to try to establish the cause of the problem.

The government stipulates that the stream is not fit for people to bathe or to get the water they use for household purposes. But the people do not believe the caution given to them. Proof has to be provided to show that the stream is, indeed, dirty. There are of course observations made - that dead fishes are seen floating in the water. The conclusion is that: living organisms are fast disappearing from the stream. Students were asked to find out what could have caused the death of the fishes, and the disappearance of other living organisms in the stream.

Picture of how the stream is used by village people.

Your Task

1. Take part in a brainstorming activity to consider possible causes of the problem.

2. Devise an investigation to show that the water in the stream is polluted.

3. Discuss results of the investigation to the class and how to combat the pollution.

4. Share the result of the scientific investigation with members of the village. Discuss the need to preserve life in the water.

5. Help the Government create awareness about making the stream alive by designing suitable posters.

Teacher's Guide

This activity relates to:

a) identifying the cause of pollution in the stream
b) determining ways to keep a stream alive
c) developing a sense of responsibility towards living things

Teaching Strategy

1. The lesson can begin by a brainstorming session in which students give ideas on possible causes of the dead fish in the stream. The teacher accepts all answers but encourages students to be specific, as much as possible, and guide responses to go beyond ' the stream is polluted' towards ideas such as ' the oxygen content of the stream is too low'.

2. The brainstorming session leads to the need to investigate the stream and to look for the causes of pollution. The students are called upon to devise tests, which their group can undertake. The teacher should guide the planning such that it includes aspects such as a) sample a stretch of water to look for living things; b) measure pH of water in different parts; c) try to determine the oxygen content; d) determine turbidity; e) sample the bed of the stream for organic matter.

3. After the investigation the students discuss their findings and suggest what might be done to remedy the situation. Their solution is probably to aerate the water. They can think of ways to do this (one possibility might be to divert the course of the stream and build a waterfall along its path - allowing the water to collect air as it falls) The students also wonder about the causes of the lack of oxygen and for this think of ways to guide the villagers to keep life in the stream.

4. Students put forward their suggestions to the village members and to the government on the **best** possible way of solving the problem of water pollution in the village. A

written report of their investigation can be sent to the village government council.

Additional Notes

Possible tests that can be carried out on the river water:

- pH
- oxygen content
- looking for insects
- looking for microorganisms
- *E-coli* tests

Student's Handout

Determining Oxygen Content

Introduction

Oxygen deficiency in the water is caused by chemical or biological processes which consume oxygen, for example, the decomposition of dead organisms. The discharge of nutrients into a lake can fertilize aquatic plants and cause profuse growth. When these plants die, oxygen is consumed. Oxygen depletion eventually leads to eutrophication. Water saturated with oxygen contains 8.8 mg/dm^3 at 20°C. With an oxygen content of between 2 and 4 mg/dm^3 most animals disappear. It is difficult for organisms to survive if the oxygen content is below 2 mg/dm^3. Initially, supersaturation in terms of oxygen can arise just under the surface of waters that is rich in nutrients. Plants give off oxygen during photosynthesis. Moreover, the oxygen content of water is dependent on temperature.

Procedure 1 A simplified method

By adding Mn(II) ions and hydroxide ions to a water sample you get a precipitate of manganese(II) hydroxide. This precipitate, which is more or less white, is oxidized quickly by the oxygen in the water, whereby you get a brown precipitate. The intensity of brown colour increases with the oxygen content.

Equipment needed

Sampling bottle (about 200 cm^3), syringe and dropping pipettes.

Chemicals

Crystalline manganese(II) chloride ($MnCl_2 \bullet 4H_2O$); Sodium hydroxide (NaOH).

Solutions

Manganese chloride solution: 43 g crystalline manganese chloride, $MnCl_2 \bullet 4H_20$, dissolved in 100 cm^3 distilled water.

Sodium hydroxide solution: 32 g sodium hydroxide, NaOH, dissolved in 100 cm^3 distilled water.

Procedure

1. Lower a water sampler into the water to the desired depth.

2. Keep it at that depth until the temperature between the water and the sampler has evened out.

3. Note the depth and temperature.

4. Determine oxygen content immediately according to the instructions below:

Determination of oxygen content

1. Pour the water from the water sampler to the sampling bottle.

2. Overfill the bottle so that nearly three times the volume of the bottle flows over.

3. Using 1 cm^3 syringes, add separately 1 cm^3 manganese (II) chloride solution and then 1 cm^3 sodium hydroxide solution. Keep the syringe needles in the sample water when you add the solutions.

4. Close the sampling bottle with the screw top, taking care that no air bubble is trapped.

5. Turn the sampling bottle upside down a few times. Check for air bubbles (If present, empty the bottle and start again from step 1).

6. Let the bottle stand for about 10 min. A precipitate will form in the bottle.

The oxygen, which is dissolved in the water sample, will oxidize the manganese(II) hydroxide precipitate into manganese(IV) oxide hydroxide. At the same time, the precipitate will turn brown. The intensity of the brown colour depends on the oxygen content in the water. Based on the colour of the precipitate, the oxygen content can be defined as follows:

white precipitate	-	very little oxygen
ivory-coloured precipitate	-	2-3 mg oxygen/dm^3
light chocolate-coloured	-	4-7 mg oxygen/dm^3
dark rust-coloured	-	8-14 mg oxygen/dm^3 (oversaturated)

Procedure 2 - By Titration

Procedure

A. Water sampling

1. Note the testing depth and water temperature.

2. Lower the water sampler to the desired depth and keep it there until the temperature difference between sampler and water has evened out.

3. Pour the water from the water sampler to the sampling bottle. Fill it slowly, with the rubber pipe at the bottom of the bottle. Overfill the bottle so that nearly three times the volume of the bottle flows over and let the water flow when you take the pipe out of the bottle.

4. Add 1 cm^3 manganese chloride solution and 1 cm^3 alkaline iodide solution. Keep the pipettes in the sampling water when you add the solutions.

5. Close the sampling bottle with the ground glass stopper so that no air bubbles remain under the stopper.

6. Keep the sampling bottle in the dark until the analysis is performed in the laboratory.

B. Oxygen determination

1. Remove the stopper carefully from the bottle and add 1 cm^3 phosphoric acid.

   When the sample is acidified, the precipitate dissolves and the manganese is reduced again to Mn(II). At the same time an amount of iodine equivalent to the amount of dissolved oxygen is formed. The iodine reacts with iodide ions in an equilibrium reaction and tri-iodide ions are formed. Due to this the sample turns yellow.

2. 100 cm^3 of the acidic solution is measured into an Erlenmeyer flask and titrated with 0.0100 mol/dm^3 sodium thiosulphate solution. The solution is titrated until it is straw coloured.

3. Add 1 cm^3 starch solution to the Erlenmeyer flask as an indicator.
   The solution now turns blue from starch and iodine, which makes it easier to see when the titration should end. The end-point in the titration is determined by the disappearance of the blue colour. The reason for adding starch when the iodine concentration is very low is that an irreversible starch-iodine compound is formed in a strong solution of iodine.

4. Continue the titration until the blue colour disappears. When you finish the titration, write down the total amount of sodium thiosulphate solution used.

Explanation

As in the simpler method, a brown precipitate is formed first. This precipitate (manganese(IV) oxide hydroxide) dissolves when mixed with acidified sodium iodide solution. At the same time iodine is formed, which corresponds to the amount of dissolved oxygen and the sample turns yellow. The yellow colour comes from the triiodide ions that are formed from iodine and iodide ions in an equilibrium reaction. By adding thiosulphate ions of a known concentration which reacts with the tri-iodide ions, the concentration of iodine can be determined.

Reactions

$2Mn^{2+} + 2OH^- + O_2 \rightarrow 2MnO(OH)_2(s)$ - brown precipitate

$MnO(OH)_2 + 4H^+ + 3I^- \rightarrow Mn^{2+} + I_3^- + 3H_2O$ yellow solution

$I_2 + 2S_2O_3^{2-} \rightarrow 3I^- + S_4O_6^{2-}$ - colourless solution

Equipment needed

Ruttner sampler, sampling bottles with ground glass stopper (approx. 200 cm^3), pipettes, volumetric flasks, 200 cm^3 beaker, burette, 250 cm^3 Erlenmeyer flask, stand and scales.

Chemicals

concentrated 85% phosphoric acid (H_3PO_4)
crystalline manganese(II) chloride ($MnCl_2 \bullet 4H_2O$)
sodium hydroxide (NaOH)
sodium iodide (NaI)
sodium thiosulphate ($Na_2S_2O_3 \bullet 5H_20$)
sodium carbonate (Na_2CO_3)
starch
salicylic acid

Solutions

- Manganese(II) chloride solution: 43.5 g crystalline manganese(II) chloride is dissolved in 100 cm^3 distilled water.

- Alkaline iodide solution: 32 g sodium hydroxide is dissolved in distilled water, the solution is cooled down and 60 g sodium iodide is added.

- 0.0100 M sodium thiosulphate solution: 2.48 g crystalline sodium thiosulphate dissolved in 1000 cm^3 distilled water. Add 0.02 g sodium carbonate to the solution as a preservative. The solution will keep for several weeks in a coloured glass bottle.

- 1% starch solution: 1.0 g starch is dissolved in 100 cm^3 cold water, after which the solution is heated almost to boiling point. Let the solution cool. 0.1g salicylic acid can be added as a preservative.

Determining Visibility

Introduction

Visibility is determined by how deeply into the water light permeates. When visibility is low it means that light is either heavily absorbed or spread. Visibility tells you, among other things, about cloudiness, colour and the content of phyto and zooplankton.

Equipment needed

A white metal or plastic disk (Secchi disk) with a diameter of 25 cm attached to a rope which is graded in decimetres. Also needed, if possible, water binoculars (figure 8: 10).

Procedure

1. Lower the Secchi disk into the water. Be careful that the disk is lowered vertically and does not drift away in the water.

2. Lower the disk until it is no longer visible and read the depth on the graded rope.

3. Lower the disk still further (approximately 0.5 m) and then pull it slowly upwards. Note the depth when it becomes visible.

4. Visibility depth is the mean of these two measurements and is measured in meters.

5. In order to avoid water reflection, work in the shade or use water binoculars.

Making a Water sampler

You can make a water sampler with a plastic bottle. Make three holes in the cork of the bottle: a tube for outgoing air, a tube for incoming water and one for a thermometer. In order to fill the bottle with water up to the bottom edge of the tube for outgoing air, place the top edge of the tube as close to the cork as possible. Place the thermometer so that you can read it without removing it. The most difficult part of making the water sampler is getting the right weight at the bottom of the bottle (over 1 kg in a one-dm^3 bottle). You need to attach the weight properly, for example, with glue so that it will remain in place even when the bottle is turned upside down to empty it. If you want to determine the oxygen content accurately, you will need a Ruttner sampler.

Determining the Organic Content of the Stream Bed

Introduction

The sediment content varies greatly from place to place. In general you can say that the sediment has an inorganic and an organic part. Inorganic material, which consists of decomposing and erosion products from land, is carried out into the sea via rivers. The speed of the current slows down quickly at the mouth and the coarsest material sediments deposit there. The organic content varies. It is low on sandy bottoms, but comprises around 20% on a clean soft bottom.

You can expect more benthic fauna in bottoms with a high organic content.

Equipment needed

Plexiglass tube (5 cm in diameter, 30 cm in length), warming cupboard, desiccator, crucible, incinerator and scales.

Procedure

1. Decide on 5 testing sites with a depth of 0.5 m, divided equally within the area.

2. Keep the tube straight and push it 5 cm down into the bottom at each testing site. Put the cork in and pull the tube upwards carefully.

3. Put the lumps of sediment in separate plastic bags.

4. Dry the sediment for 24 hours in a warming cupboard (105°C).

5. Let it cool in a desiccator for 30 min. and weigh it (= a g).

6. Put the sediment in a crucible and incinerate the sediment in the incinerator (at approximately 600°C) for one hour.

7. Let it cool in the desiccator and weigh it (= b g).

8. Calculate the organic content of the sediment in the different testing sites.

$$\text{Organic content} = \frac{100\,(a-b)}{a}$$

Achieving the objectives

Objective	This is achieved by
1. Having a positive attitude towards, and a sense of responsibility for, living things.	participating in group discussions with the class and with members of the village.
5. Encourage fellow students To develop respect, awareness and concern for their local environment.	participating in group discussions and writing a report to the village council.
3. Identify ways of keeping the stream alive.	discussing results of scientific investigations.
4. Co-operating as a member of a group.	co-operating during the experimental work and in the group discussions.
5. Communicating orally.	students taking an active part in discussions within the group.
6. Put forward suggestions of the likely causes of the problem	brainstorming and group discussion.
7. Testing the presence of oxygen in water and hence determining the causes of oxygen reduction in the stream.	undertaking group experiments and the subsequent follow up calculations.

Assessment:

Able to give a Social Values grade (objectives 1 and 2)

A. Not willing to exhibit any concern for living things in the river, nor to solving a social problem. Unwilling to play a role in the development of a poster.

B. Shows concern for living things. Exhibits a positive attitude towards care for the river. Plays a full part in designing and developing the poster.

C. Shows awareness of seriousness of the water pollution problems and a concern to the positive action. Can suggest how other can be made to show concern for the problem through developing a creative and appealing poster.

Able to give a Science Method grade (objective 3)

A. Not usually able to devise experiments to show how water can be tested. If able to put forward suggestions such as measuring the pH, is not able to suggest how this can be determined meaningfully.

B. Able to put forward suggestions for experiments to test the water and be able to specify apparatus, etc. that can be used to carry out the experiments.

C. Able to put forward experiments and the necessary parameters or variables that must be controlled in undertaking the experiments.

Able to give a Personal grade (objectives 4 and 5)

A. Not able to put forward suggestions or communicate in the discussions. Does not participate effectively in the experimental work.

B. Willing to put forward suggestions and cooperate in the discussions in the experimental work.

C. Able to guide the group towards a consensus opinion and in carrying out the experimental work efficiently and effectively.

Able to give a Science Concept grade (objectives 6 and 7)

A. Not able to undertake the experiments meaningfully.

B. Able to undertake the experiments and make suitable inferences from the results.

C. Able to infer the level of pollution from undertaking the experiments. Able to understand the likely causes of the pollution.

Summative Assessment Strategies

Able to give a Social Values grade (objectives 1 and 2)

A. Design of poster poor and ineffective in giving an attitudinal message to the general public on the need to show greater environmental awareness.

B. Able to produce a poster that can influence the public to be more environmentally aware to the ways the river can be pollution and how this can be prevented.

C. Able to produce a creative poster that can influence the attitude of the general public towards the environment and the aesthetic value that can be incorporated into suitable remedial measures.

Able to give a Science Concept grade (objectives 6 and 7)

A. Report shows poor understanding of the experimental tests undertaken and gives little information of possible remedies to the problem.

B. Able to develop a report that shows understanding of the tests undertaken to determine the pollution of the river and the suggested actions to be taken.

C. Able to develop a concise report inferring the outcomes of the experimental tests carried out and the possible actions that can be undertaken in order to priority of effectiveness.